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Source Emission Tests at the Baltimore Demonstration Pyrolysis Facility

TRW Environmental Engineering Div, Vienna, VA

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16. ABSTRACT

TRW was retained by EPA/IERL Cincinnati in May of 1976 to conduct source emission tests at a solid waste treatment plant in Baltimore, Maryland. The plant is designed to recover low-grade fossil fuel from non-toxic solid waste by the use of a process known as pyrolysis. When plant construction was completed in January, 1975, it was determined that the pollutant control equipment did not meet particulate emission standards. This necessitated a comprehensive test program designed to quantify the extent of the pollution and evaluate the environmental impact of this plant. The test program was designed to measure the following flue gas parameters; particulate; SO_2/SO_3;NO_x;HCl:HF; total hydrocarbons; hydrocarbon compounds exceeding 1% of the total hydrocarbon value, but not more than 20; and trace metals.

Atmospheric diffusion models were employed to assess the environmental impact of both the existing plant configuration and the proposed pollution control system. The proposed system consists of an electro-static precipitator exhausting to a 220 ft. stack. Results of this analysis indicate that the proposed pollution control system represents a considerable improvement over the existing system, particularly in the sense that it should completely eliminate the downwash problem.

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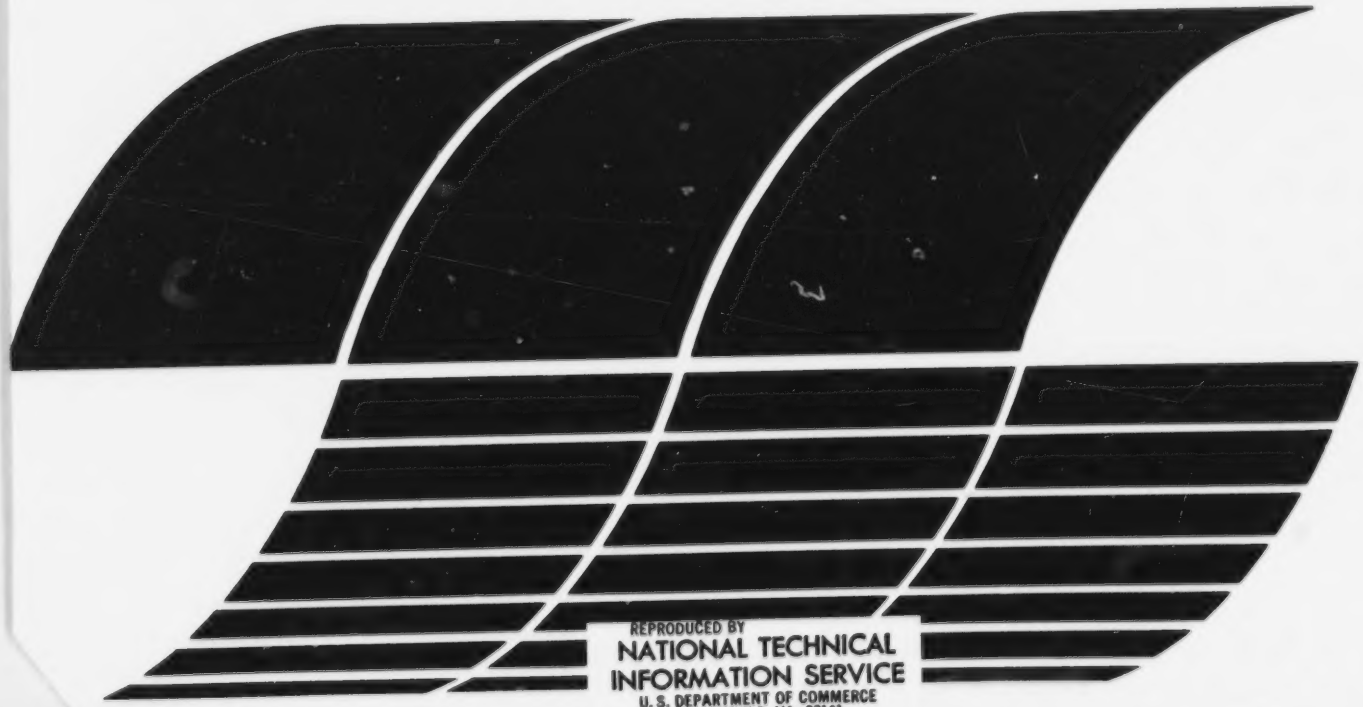

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December 1978

SOURCE EMISSION TESTS AT THE BALTIMORE DEMONSTRATION PYROLYSIS FACILITY

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This report describes the results of a comprehensive field test program designed to characterize air emissions from the Baltimore Maryland demonstration pyrolysis plant. The results of this study will be useful to design appropriate pollution control equipment for this and similar waste-as-fuel plants. Requests for further information concerning air emissions from waste-as-fuel systems should be directed to the Fuels Technology Branch, IERL-Ci.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

TRW was retained by EPA/IERL Cincinnati in May of 1976 to conduct source emission tests at a solid waste treatment plant in Baltimore, Maryland. The plant is designed to recover low-grade fossil fuel from non-toxic solid waste by the use of a process known as pyrolysis. When plant construction was completed in January, 1975, it was determined that the pollutant control equipment did not meet particulate emission standards. A permit was issued to operate out of compliance, while various modifications were implemented to reduce emissions. When this permit expired in January, 1976, its renewal was contingent upon a comprehensive test program designed to quantify the extent of the pollution and evaluate the environmental impact of a newly proposed control system on air quality in the surrounding area.

The emission tests were conducted at two locations, one at the inlet and one at the outlet of the particulate scrubber. The test program was designed to measure the following flue gas parameters: particulate; SO_2/SO_3;NO_x; HCl; HF; total hydrocarbons; hydrocarbon compounds exceeding 1% of the total hydrocarbon value, but not more than 20; and trace metals.

Average grain-loading for the series of three tests at the outlet location was 0.255 grains per dry standard cubic foot of stack gas. The average concentrations of SO_2 and SO_3 at the scrubber outlet were 10 ppm and 8 ppm, respectively. Measurements of SO_2/SO_3 in and out of the scrubber show that approximately 93% of the SO_2 and a negligible amount of SO_3 was removed by the scrubber. Average concentration of NO_x in the flue gas was 4 ppm at the inlet and 5 ppm at the outlet. These results are somewhat suspect in that the amount of NO_x collected is close to the lower limit of precision inherent in the method.

One sampling train was used to measure both hydrocarbons and trace elements at each location. Hydrocarbons were extracted and subsequently analyzed by gas chromatography in two fractions. Samples of fly ash collected on 4 inch filters were taken for spark-source, mass spectrometric elemental analysis. High concentrations of the metals iron, zinc, tin, and lead were found in the particulate samples taken at each location.

Atmospheric diffusion models were employed to assess the environmental impact of both the existing plant configuration and the proposed pollution control system. The proposed system consists of an electro-static precipitator exhausting to a 220 ft. stack. Results of this analysis indicate that the proposed pollution control system represents a considerable improvement over the existing system, particularly in the sense that it should completely eliminate the downwash problem, which currently contributes to high levels of particulate in the area surrounding the pyrolysis facility.

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SECTION I

INTRODUCTION

TRW Environmental Engineering, a division of Energy Systems Group, was retained by EPA/IERL Cincinnati, Fuels Technology Branch, to conduct source emission tests at a solid waste treatment plant in Baltimore, Maryland. This plant is a demonstration unit based upon Monsanto's Landgard system, a process whereby non-toxic solid waste is subjected to pyrolysis in order to produce a fuel capable of generating steam energy.

The emission tests were conducted at a location directly downstream from the pyrolysis vessel known in the plant as the boiler discharge duct, and at a location on the outlet side of the particulate scrubber known as the C-8 duct (see Figure 1). For the purpose of simplification, these locations will hereafter be referred to as the inlet and outlet of the particulate scrubber, respectively. Emission tests were conducted to determine concentrations of the following constituents in the flue gas: particulates; SO_2/SO_3; HCl; HF; total hydrocarbons; hydrocarbon compounds exceeding 1% of the reported total hydrocarbon value, but not more than 20; antimony and compounds; arsenic and compounds; cadmium and compounds; lead and zinc chromates; iron oxide; lead; molybdenum; nickel compounds; selenium compounds; rhodium; soluble salts; tin oxide; tungsten and compounds; vanadium oxide; zirconium compounds; and mercury. With the exception of particulate which was measured only at the outlet, all of the preceding flue gas constituents were measured at each location. After numerous delays in the test program due to plant malfunctions, the actual field testing was begun on November 15, 1976. Sampling for particulate, SO_x, NO_x, HCl, HF, and total acidity was completed on November 17, 1976. After an additional delay in plant operation, samples of hydrocarbons and trace elements in the flue gas were collected on December 10, 1976.

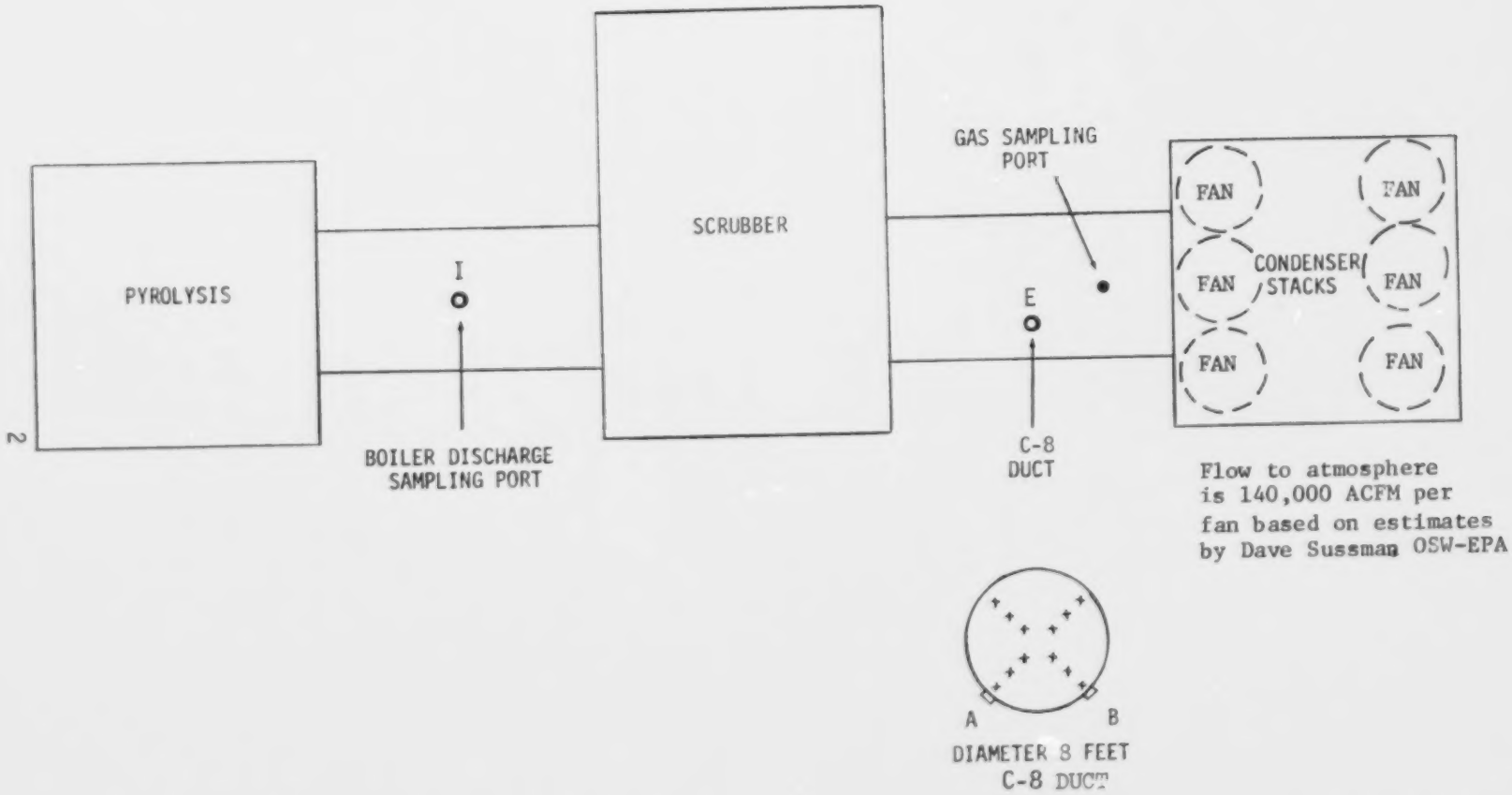


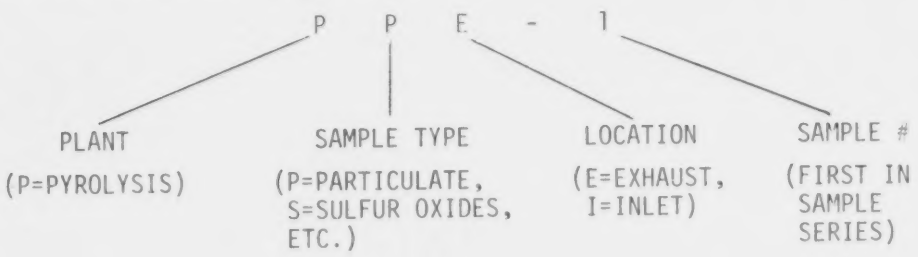
Figure 1. Schematic diagram of sampling sites.

SECTION II

DISCUSSION OF RESULTS

The entire test program progressed smoothly with no significant problems encountered in the collection of samples. The sampling and analytical methodology employed in this test program is described in detail in the following two sections of this report. Operation of the pyrolysis plant was fairly constant throughout the test period, and, hence, the results are intended to reflect the composition of the flue gas under steady state conditions. A summary of plant operation during the test periods is presented (Table 1).

All samples in this report are designated by a three-letter code followed by a number indicating the order in which the sample was taken. For example:



Flue gas particulate was measured only at the outlet of the particulate scrubber. A complete listing of particulate results is presented (Table 2). Average grain-loading for the series of three tests was 0.410 g/dscm (0.179 gr/dscf). The pyrolysis unit is considered to be a solid waste incinerator. Emission rates for this type of unit are typically adjusted to 12% CO_2 to negate any air inleakage between the incinerator and the point at which gas is discharged to the atmosphere. Average grain-loading for the three tests adjusted to 12% CO_2 is 0.584 g/dscm (0.255 gr/dscf). Particulate emissions during the first test were approximately 30% higher than the other two. However, when the emission rates are corrected to 12% CO_2, this degree of difference becomes less acute, and the results are fairly consistent considering the accuracy of the method.

TABLE 1. PLANT OPERATING DATA

DATE	11/15/76			11/16/76						12/10/76					
TIME	1500	1600	1700	1100	1200	1300	1400	1500	1600	1100	1200	1300	1400	1500	1600
PLANT OPERATING CONDITIONS															
THROUGHPUT (TONS/HR)	30	30	30	31	31	31	31	31	31	20	25	23	25	35	34
TEMPERATURES (°F)															
KILN FEED END	1650	1650	1620	1630	1640	1690	1580	1500	1720	1530	1510	1480	1490	1360	1420
KILN FIRE END	1700	1680	1650	1550	1500	1500	1550	1600	1550	2080	2050	2100	2050	2050	1850
GAS PURIFIER	2560	2550	2660	2570	2650	2460	2460	2350	2550	2650	2600	2640	2510	2500	2540
BOILER INLET (B1)	1780	1750	1920	1700	1720	1670	1700	1630	1720	1500	1560	1540	1470	1600	1400
BOILER INLET (B2)	1600	1600	1780	1560	1600	1530	1580	1520	1600	1410	1490	1480	1500	1660	1520
BOILER OUTLET	610	640	680	590	600	600	600	600	500	490	520	520	520	520	520
ID FAN INLET	142	141	151	146	148	147	147	147	146	140	144	143	144	144	144
ID FAN OUTLET	143	141	150	148	148	148	148	147	147	141	146	145	146	145	146
KILN (RPM)	0.75	0.75	0.75	0.75	0.75	0.75	1.0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
SCRUBBER FLOW (GPM)	2600	2600	2600	2700	2700	2700	----	----	----	2100	2100	2100	2100	2100	2100
SCRUBBER OUTLET (pH)	6.7	6.6	6.6	6.6	6.6	6.9	7.3	7.2	7.0	----	----	----	----	7.5	6.5
ID FAN, DAMPER SETTING (°)	20	20	20	20	25	20	25	28	24	22	20	20	22	25	22
ID FAN, AMPS	135	135	135	150	150	150	175	180	165	135	145	140	145	165	163
REMARKS	STEADY OPERATION; BLEW BOILER TUBES AT 1430			1140 - C5 FAN ON 1505 - RAM JAM						1 SCRUBBER PUMP INOPERATIVE BLEW BOILER TUBES PRIOR TO TEST					

TABLE 2. PARTICULATE RESULTS, SCRUBBER OUTLET

RUN NUMBER	PPE-1	PPE-2	PPE-3
DATE	11/15/76	11/16/76	11/16/76
TEST TIME (24 HOUR CLOCK)	1540-1700	1120-1240	1440-1555
PLANT THROUGHPUT (TONS/HR)	30	31	31
FLUE GAS VOLUME (SCFM-Dry)	113,868	90,321	92,623
PERCENT MOISTURE	12.3	15.3	13.0
PERCENT CO_2	9.5	9.5	8.0
PARTICULATE EMISSIONS (gr/scf)	0.213	0.163	0.160
PARTICULATE EMISSIONS (lb/hr)	208.1	126.0	127.3
PARTICULATE EMISSIONS (gr/scf) (CORRECTED TO 12% CO_2)	0.297	0.227	0.241
PERCENT ISOKINETIC	90	97	95

The average concentrations of SO_2 and SO_3 for the series of three tests at the inlet of the particulate scrubber were 149 ppm and 10 ppm, respectively. Average SO_2 concentration at the outlet location was 10 ppm, representing approximately 93% removal of SO_2 in the scrubber. Virtually no SO_3 was removed in the scrubber. The average concentration of SO_3 at the scrubber outlet was 8 ppm. Results of individual tests at the same location were reproducible well within the analytical precision of the method used.

Grab samples of flue gas at each location were taken and analyzed for nitrogen oxides. Average concentration of NO_x was 4.1 ppm at the inlet location, and 5.0 ppm at the outlet. An average of three NO_x samples was taken for each test series. Agreement among these results was fairly good, considering that the amount of NO_x collected was close to the lower limit of precision in the method.

Samples of flue gas at each location were slowly bubbled through dilute alkali to capture the halogens, F^- and Cl^-, and measure total acidity. The average concentration of chloride ion at the scrubber inlet was measured at 762 ppm. Chloride concentration at the outlet location averaged 68 ppm, showing a significant reduction in chloride across the scrubber. Fluoride concentration averaged 5.2 ppm inlet and 0.6 ppm outlet. Only two samples were found to be acidic, PGI-1 and PGI-2, therefore only two results for total acidity are reported.

Analytical results for all gaseous samples taken (SO_x, NO_x, F^-, Cl^-, and total acid) are presented (Tables 3 and 4).

Two integrated gas samples, one at each location, were taken in Tedlar bags for subsequent C_1-C_6 hydrocarbon analysis. Samples of flue gas to be analyzed for C_7-C_{12} hydrocarbons were collected in a sorbent trap containing XAD-2 polymer resin (see diagram of sampling train, Figure 2). Gaseous samples had to be taken for the low molecular weight hydrocarbons since these compounds are typically too volatile to be completely captured in the sorbent trap. Results of hydrocarbon analyses are presented (Table 5). C_1-C_6 hydrocarbons are given in terms of milligrams of n-alkanes, as butane, per cubic meter of sample gas. C_7-C_{12} hydrocarbons were extracted in pentane from the sorbent trap and reported as micrograms of n-alkane, as decane, per milliliter of extract. To obtain the total amount of each hydrocarbon in the sample, this

TABLE 3. GAS SAMPLING RESULTS, SCRUBBER INLET

	Test #1	Test #2				Test #3		
Sulfur Oxides								
Sample #	PSI-1	PSI-2				PSI-3		
Date	11/15/76	11/16/76				11/16/76		
Time	1535-1635	1115-1215				1450-1550		
Sample Volume (SCFD)	43.7	35.5				48.4		
SO_2 (PPM)	171	157				120		
SO_3 (PPM)	11	11				7		
Nitrogen Oxides								
Sample #	PNI-1	PNI-2	PNI-3	PNI-4	PNI-5	PNI-6	PNI-7	PNI-8	PNI-9
Date	←11/15/76→		←11/16/76→				←11/16/76→		
Time	1600	1615	1152	1222	1245	1250	1450	1430	1625
NOx (PPM)	18.9	1.3	8.5	0.5	0.5	0.5	0.3	5.3	2.5
Total Acids									
Sample #	PGI-1	PGI-2				PGI-3		
Date	11/15/76	11/16/76				11/16/76		
Time	1548-1618	1118-1148				1459-1529		
pH	3.6	2.4				7.2		
Cl^- (PPM)	445	590				1250		
F^- (PPM)	7.6	4.8				3.3		
Acidity (mg/l $CaCO_3$)	63.5	293.3				Basic		

TABLE 4. GAS SAMPLING RESULTS, SCRUBBER OUTLET

	Test #1	Test #2				Test #3		
Sulfur Oxides								
Sample #	PSE-1	PSE-2				PSE-3		
Date	11/15/76	11/16/76				11/16/76		
Time	1537-1637	1113-1213				1452-1552		
Sample Volume (SCFD)	38.1	36.1				37.0		
SO_2 (PPM)	8	15				7		
SO_3 (PPM)	9	8				7		
Nitrogen Oxides								
Sample #	PNE-1	PNE-2	PNE-3	PNE-4	PNE-5	PNE-6	PNE-7	PNE-8	PNE-9
Date	←11/15/76→		←11/16/76→				←11/16/76→		
Time	1540	1620	1138	1215	1230	1255	1456	1536	1610
NOx (PPM)	10.8	3.9	7.9	1.4	2.7	8.4	2.5	5.6	2.3
Total Acids									
Sample #	PGE-1	PGE-2				PGE-3		
Date	11/15/76	11/16/76				11/16/76		
Time	1614-1644	1232-1302				1605-1635		
pH	8.0	7.7				7.8		
Cl^- (PPM)	33	32				140		
F^- (PPM)	0.3	0.2				1.2		
Acidity (mg/l $CaCO_3$)	Basic	Basic				Basic		

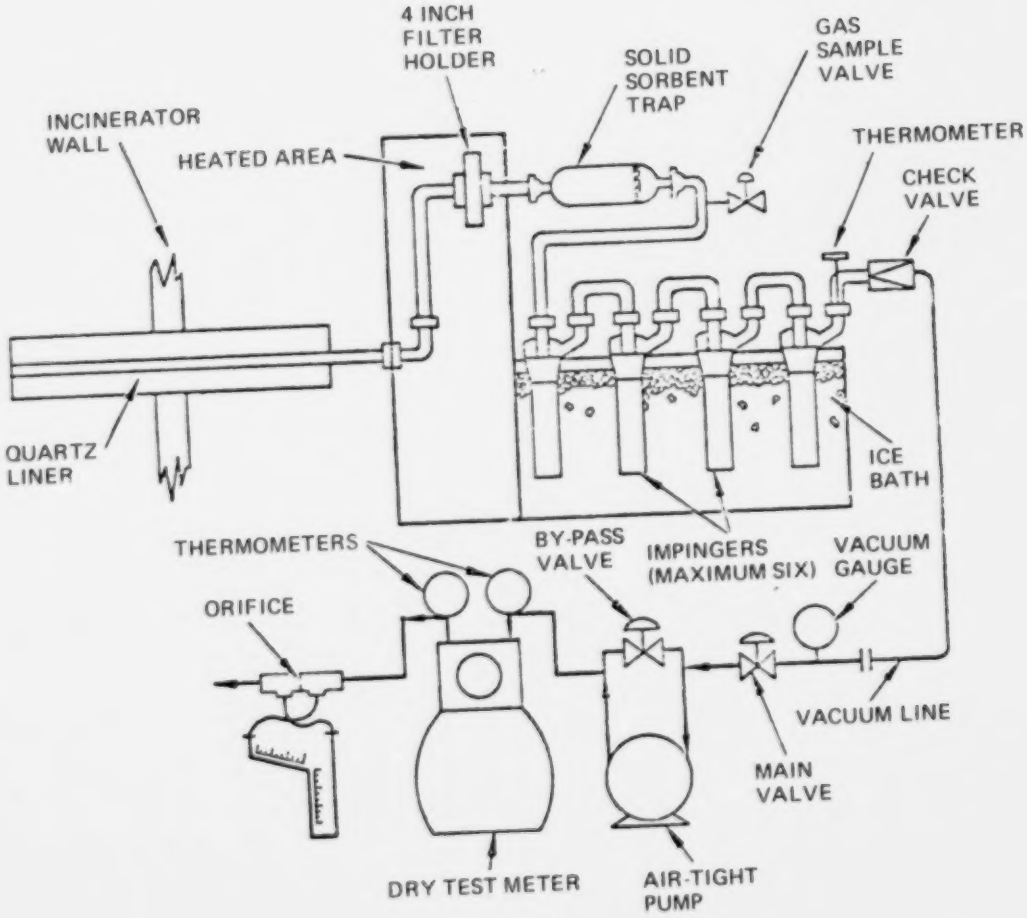


Figure 2. Hydrocarbon/trace element sampling train.

TABLE 5. RESULTS OF HYDROCARBON ANALYSIS

C1 - C6 ANALYSIS

SAMPLE #	DATE	TIME	CONCENTRATION (mg/m^3) n-ALKANES, CALCULATED AS BUTANE					
			C1	C2	C3	C4	C5	C6
PPIN-1	11/17/76	1130-1215	85	<0.6	833	1634	<0.6	682
PPEX-1	11/17/76	1215-1725	13	<0.6	234	564	<0.6	584

C7 - C12 ANALYSIS

SAMPLE #	DATE	TIME	CONCENTRATION (µg/ml)*, CALCULATED AS n-DECANE					
			C7	C8	C9	C10	C11	C12
PPIN-1	11/17/76	1210-1640	37	29	<1.8	<1.8	<1.8	<1.8
PPEX-1	11/17/76	1215-1725	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
BLANK	-	-	<1.8	<1.8	<1.8	<1.8	40	15

*MULTIPLY BY 200 (SIZE OF EXTRACT) TO OBTAIN TOTAL µg IN SAMPLE.

concentration must be multiplied by the amount of sample extracted, 200 ml. The sample blank showed abnormally high amounts of C_{11} and C_{12} hydrocarbons. Though the exact cause of these peaks in the blank are unknown, possible explanations are: (a) contamination of blank during preparation and (b) contaminated syringe. Owing to time pressure, the analysis could not be repeated.

The results of spark-source mass spectrometric elemental analysis are presented (Table 6). One sample at each location plus a blank were analyzed. In addition, two samples collected in previous work done by Koppers at the Baltimore pyrolysis plant were analyzed at the request of Dave Sussman, EPA. These samples are labelled 76-13 and 76-14, and were taken upstream from the particulate scrubber. Concentrations of each element are reported in micrograms per milliliter of extract. To find the total weight extracted from the filter, multiply the concentration by 100 ml, the final extract volume. The major elements contained in samples collected by TRW personnel were the metals; iron, zinc, tin, and lead. High amounts of chlorine, potassium, and calcium were also found on the filters, but these elements also appeared in high concentration on the filter blank, thus no conclusion can be drawn from these results. No significant differences in trace element analysis between inlet and outlet samples were discernible.

A discussion of atmospheric dispersion analysis based upon emission rates measured in this test program for both the existing plant and the proposed stack is presented in Section V of this report.

TABLE 6. RESULTS OF SSMS ANALYSES OF FILTERS

ELEMENT	CONCENTRATION, µg/ml				
	B-INLET	B-OUTLET	B-BLANK	76-13	76-14
H	NR	NR	NR	NR	NR
Li	8	0.2	0.1	0.05	0.05
Be	0.007	0.005	0.004	<0.005	<0.001
B	0.2	0.4	0.4	1	2
C	NR	NR	NR	NR	NR
N	NR	NR	NR	NR	NR
O	NR	NR	NR	NR	NR
F	MC	≥80	≥70	≥0.8	≥7
Na	>23	>30	>26	>15	>21
Mg	MC	MC	MC	60	25
Al	>9	>11	>10	>6	>8
Si	MC	15	MC	4	19
P	MC	MC	6	7	14
S	>55	>70	2	5	10
Cl	MC	MC	MC	7	18
K	MC	MC	MC	>72	MC
Ca	MC	MC	MC	MC	MC
Sc	0.1	0.07	0.06	≤0.007	≤0.006
Ti	MC	6	5	7	21
V	0.3	0.2	0.2	0.009	0.02
Cr	MC	3	0.9	0.7	0.7
Mn	91	1	0.1	0.1	0.08
Fe	MC	54	6	3	4
Co	17	0.2	0.08	0.02	0.06
Ni	29	3	0.6	0.5	0.3
Cu	1	10	0.09	0.5	2
Zn	MC	MC	0.4	4	11
Ga	1	0.9	0.1	0.02	0.03
Ge	0.2	0.6	≤0.01	≤0.006	≤0.02
As	2	2	0.4	0.05	0.3
Se	0.5	0.1	≤0.05	≤0.02	0.08
Br	0.6	0.2	0.2	0.02	0.07

MC = Major Component, >100 µg/ml
NR = Not Reported, <0.005 µg/ml

TABLE 6 (Continued)

ELEMENT	CONCENTRATION, µg/ml				
	B-INLET	B-OUTLET	B-BLANK	76-13	76-14
Rb	0.3	2	0.03	0.04	0.07
Sr	6	2	0.4	0.9	1
Y	0.07	0.07	0.03	≤0.004	0.007
Zr	0.1	0.7	0.3	0.1	0.2
Nb	0.01	≤0.01	≤0.01	0.008	≤0.009
Mo	2	0.6	0.05	0.02	0.2
Ru	<0.008	<0.01	<0.009	<0.005	<0.007
Ph	<0.008	<0.01	<0.009	<0.005	<0.007
Pd	<0.008	<0.01	<0.009	<0.005	<0.007
Aq	0.9	0.5	≤0.01	0.05	0.08
Cd	3	0.8	0.02	0.04	0.1
In	STD	STD	STD	STD	STD
Sn	MC	20	0.09	1	2
Sb	28	7	≤0.03	0.2	0.3
Te	0.03	≤0.02	≤0.02	<0.005	<0.007
I	0.02	≤0.01	≤0.01	0.006	0.02
Cs	0.06	0.7	0.4	1	0.5
Ba	MC	10	1	1	0.9
La	0.9	0.3	0.07	<0.005	≤0.02
Ce	1	0.3	0.06	0.009	0.01
Pr	0.1	0.04	0.02	<0.005	<0.007
Nd	0.2	0.1	0.03	<0.005	<0.007
Sm	0.1	0.08	0.04	<0.005	<0.007
Eu	0.02	0.02	0.01	<0.005	<0.007
Gd	0.04	0.03	<0.009	<0.005	<0.007
Tb	0.01	0.01	<0.009	<0.005	<0.007
Dy	0.04	<0.01	<0.009	<0.005	<0.007
Ho	0.04	<0.01	<0.009	<0.005	<0.007
Er	0.02	<0.01	<0.009	<0.005	<0.007
Tm	0.006	<0.01	<0.009	<0.005	<0.007
Yb	0.05	<0.01	<0.009	<0.005	<0.007
Lu	0.009	<0.01	<0.009	<0.005	<0.007

MC = Major Component, >100 µg/ml
STD = Standard

TABLE 6 (Continued)

ELEMENT	CONCENTRATION, µg/ml				
	B-INLET	B-OUTLET	B-BLANK	76-13	76-14
Hf	0.05	<0.01	<0.009	<0.005	<0.007
Ta	0.05	<0.01	<0.009	<0.005	<0.007
W	0.09	≤0.06	≤0.05	≤0.03	≤0.06
Re	<0.008	<0.01	<0.009	<0.005	<0.007
Os	<0.008	<0.01	<0.009	<0.005	<0.007
Ir	<0.008	<0.01	<0.009	<0.005	<0.007
Pt	<0.008	<0.01	<0.009	<0.005	<0.007
Au	≤0.008	<0.01	<0.009	<0.005	<0.007
Hg*	0.16	0.20	0.005	0.11	0.025
Tl	≤0.03	≤0.03	≤0.02	≤0.02	≤0.03
Pb	MC	MC	0.1	14	12
Bi	0.3	0.4	≤0.02	0.05	0.05
Th	0.1	0.2	≤0.1	0.005	≤0.08
U	<0.06	≤0.09	≤0.07	<0.005	≤0.06

MC = Major Component, >100 µg/ul
* = Hg analyzed by cold vapor atomic absorption spectrophotometry.

SECTION III

SAMPLING EQUIPMENT AND METHODOLOGY

All raw test data are included in Appendix A to this report.

PARTICULATE

Flue gas particulate concentrations were measured only at the outlet location. The sampling procedure used was EPA Method 5 as outlined in the Federal Register (40 CFR, Part 60, Appendix A). A diagram of the sampling apparatus is shown (Figure 3).

CARBON DIOXIDE

Flue gas samples were taken through a sampling tube at each location and aspirated into a Fyrite analyzer from which the percentage of CO_2 present in the flue gas can be read directly.

SULFUR OXIDES

SO_2/SO_3 concentrations were measured using a modified version of EPA Method 6. In this method, SO_3 is collected in an impinger containing a solution of 80% isopropanol. Any SO_3 carryover is collected on a filter located between the first and second impingers. The second and third impingers collect SO_2 in a solution of 3% hydrogen peroxide. Sampling is carried out isokinetically at a single point in the stack. A diagram of the sulfur oxide sampling train is shown (Figure 4).

OXIDES OF NITROGEN

Oxides of nitrogen were sampled according to EPA Method 7. This method calls for a grab sample of the flue gas to be collected in an evacuated flask containing 25 ml of a dilute sulfuric acid-hydrogen peroxide absorbing solution. An average of three NO_x samples were taken during each one-hour test period.

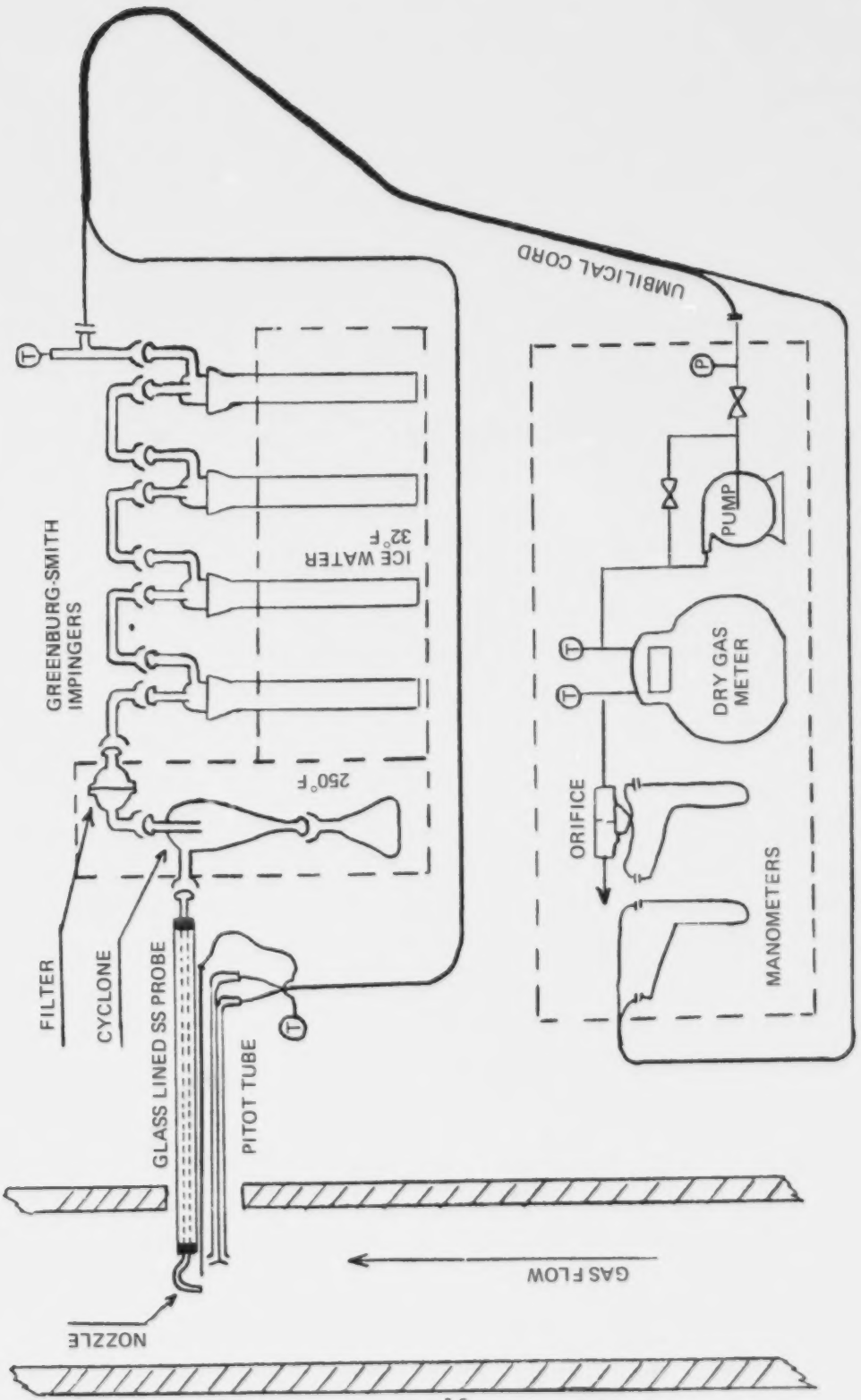


Figure 3. Particulate sampling train.

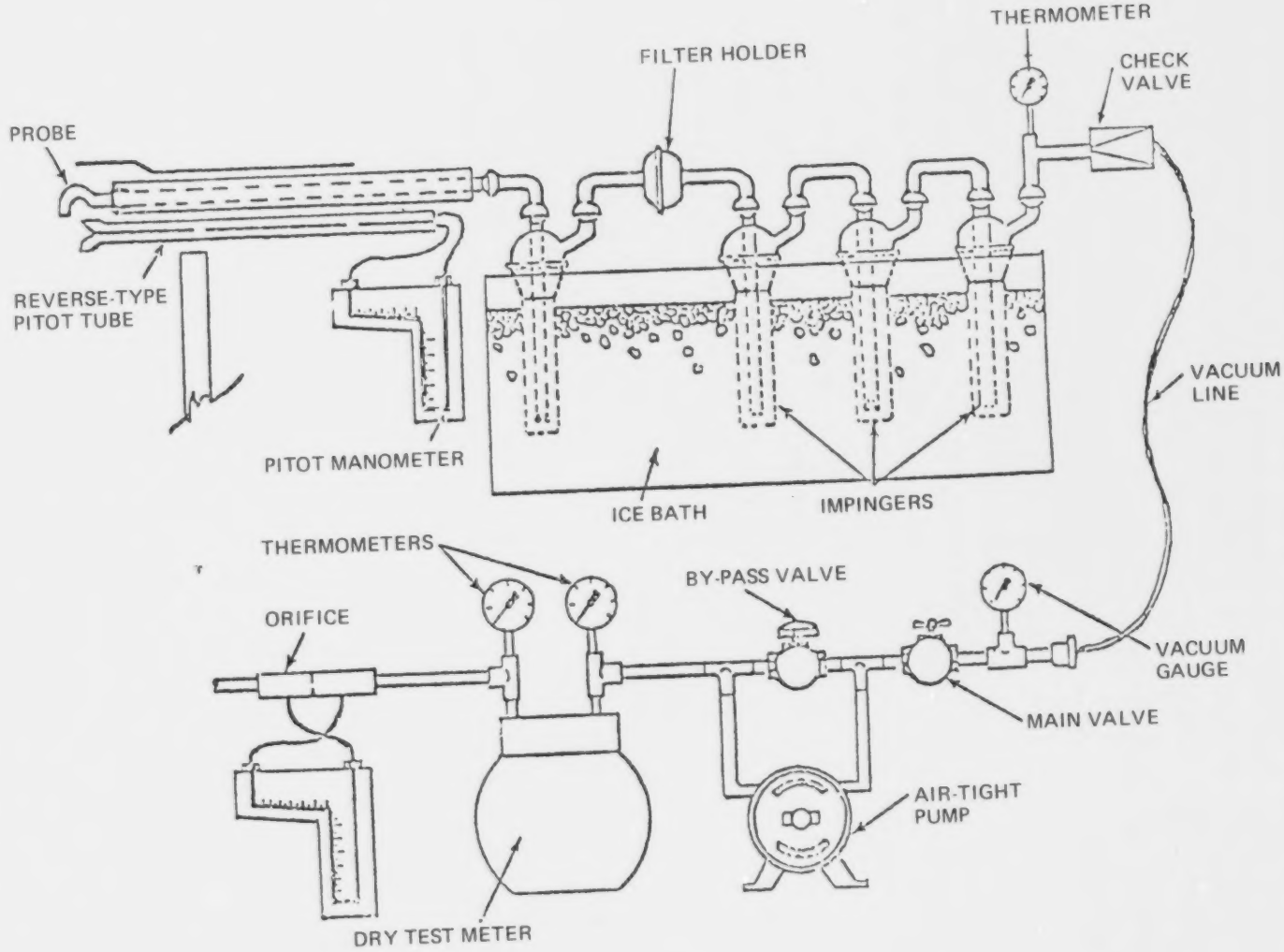


Figure 4. SO_2/SO_3 sampling train.

HCl, HF, ACIDITY

A modified version of EPA Method 6 was used to determine the acid content of the flue gas. In this case, a dilute solution of sodium hydroxide (0.1N NaOH) was used as the absorbing solution. Results are reported in terms of parts per million F^- and Cl^- and total acidity.

HYDROCARBONS AND TRACE ELEMENTS

One sampling train was used to measure both hydrocarbons and trace elements at each location. A diagram of this train is shown (Figure 2). The technique employed in extracting and analyzing these samples is similar to procedures developed by TRW for the EPA, known as a Level 1 Environmental Assessment.* The sample was extracted at a constant flow rate for about 4 to 5 hours to produce a sample size of approximately 7.1 SCMD (250 SCFD) of stack gas. The gas sample passes through an unheated probe on to a filter which collects all non-volatile particulate matter, which is recovered for trace metal analysis. After passing through this filter, the sample gas immediately enters a solid sorbent trap designed to capture high molecular weight hydrocarbons (C_7-C_{12}). The trap contains XAD-2 sorbent, a porous polymer resin with the capability of absorbing a wide range of organic species. Following the sorbent trap, the sample gas passes through a series of impingers in which moisture is removed before entering the dry gas meter by which sample volume is recorded. Low molecular weight hydrocarbons (C_1-C_6) were collected in an evacuated, airtight gas sample bag using a time integrated sampling rate employed at intervals throughout the test period.

*Hamersma, J. W., "IERL-RTP Procedures Manual: Level 1 Environmental Assessment," EPA-600/2-76-160 a, June 1976.

SECTION IV

ANALYTICAL PROCEDURES

PARTICULATE, SO_x, AND NO_x

Particulate, sulfur oxides, and nitrogen oxides were sampled and analyzed according to standard reference methods published in the Federal Register (40 CFR, Part 60, Appendix A) on October 6, 1975, with subsequent modifications and additions.

TOTAL ACIDS

A sample of flue gas was taken to determine concentrations of the halogens, fluorine and chlorine, and total acidity. Fluorine and chlorine were measured directly from the sample absorbing solution with the use of a specific ion electrode. To determine total acidity the pH of the sample was measured and an amount of standard acid added, as needed, to lower the pH to 4 or less. The sample was then titrated electrometrically with standard calcium carbonate to pH 8.2. Acidity is reported in terms of mg/l $CaCO_3$.

HYDROCARBONS

A flue gas sample was taken in a Tedlar bag for C_1-C_6 hydrocarbon analysis. Analysis was accomplished by the use of gas chromatography. A standard n-butane in helium mixture was used for calibration. The minimum detectable quantity was calculated to be 0.6 mg/m^3. A mixture of methane, propane, butane, pentane and hexane was used to establish retention times. Concentrations are reported in terms of milligrams of alkane per cubic meter of gas sample and are expressed in units of the n-alkanes calculated as butane.

Hydrocarbons in the C_7 to C_{12} range were captured in XAD-2 sorbent. The samples were extracted with pentane and then analyzed by GC. The minimum detectable quantity was calculated to be 1.8 µg/ml. Serial dilutions of a

known amount of n-decane in pentane were used for calibration. Results are calculated as n-decane and are reported in terms of micrograms per milliliter.

TRACE ELEMENTS

Flue gas particulate samples were collected for trace metal analysis. The filter samples were extracted in constant-boiling aqua regia. The extracts were made to 100 ml in volumetric flasks, and 20 ml aliquots were taken for spark-source, mass spectrometric elemental analysis.

SECTION V

DISPERSION ANALYSIS

PURPOSE OF ANALYSIS

For the comparison of alternative emission control options or for predicting the effects of changes in an emission source, one of several procedures might be used:

- Ground level pollutant concentration measurements can be made for each source configuration of interest so that air quality impacts are determined directly.
- Observed results from other similar systems can sometimes be used to implement decisions.
- Air quality diffusion modeling may be used for the assessment.

The first technique is extremely expensive and time-consuming, and has been used in relatively few instances. In addition to these disadvantages, this method is not easily applicable to situations where other sources may be contributing to the air quality measurements, as would be true in most urban and industrial areas. Using results from other sources is generally not applicable where the source being investigated is based on novel technology, as exemplified by the pyrolysis unit. However, even if a similar source could be located where the needed tests had been performed, it would be highly unlikely that the meteorological parameters and operating characteristics would be sufficiently similar to those of the pyrolysis unit.

By process of elimination, diffusion modeling is the only generally applicable technique for making predictions of the air quality impacts of changes in emission source configurations. Moreover, diffusion analysis can

also give an indication of the effects of changes in meteorology, and the technique is very conservative of both labor and materials.

In making use of modeled air quality data, some caveats should be noted:

1. Even apparently sophisticated models represent only crude approximations of highly complex atmospheric processes.

2. In using an uncalibrated model, one should not place too much emphasis on the absolute values of predicted air quality levels. Instead, the differences or ratios of pollutant concentrations should receive the most attention.

3. In most cases--including the present one--one must make use of meteorological data obtained at a site some distance from the source being modeled, and there may be large differences in such parameters as wind speed.

Irregardless of these limitations, the comparison of various source configurations under identical meteorological and operating conditions is the problem which diffusion modeling is best equipped to handle when care is taken in interpreting the results. The methodology used for modeling the pyrolysis unit is briefly described in the following paragraphs, and a discussion of the results concludes Section V.

METHODOLOGY

Violations of ambient air quality standards resulting from relatively small emission sources such as the pyrolysis unit normally occur as localized short-term excursions, such as 1-hour or 24-hour violations. Although the unit contributes to the total annual pollution burden in the Metropolitan Baltimore Air Quality Control Region (AQCR), the impact is minimal in comparison with other emissions in the Region.* Consequently, with the

*For example, at design rate (680 metric tons/day [750 tons/day], 280 days per year), the pyrolysis unit particulate emissions represent less than 1% of the AQCR total.

concurrence of representatives of the Maryland Bureau of Air Quality and Noise Control (BAQNC), it was decided that only short-term modeling would be performed.

Two types of air quality models were used for the analysis:

- PTMAX, which determines the maximum, short-term, ground level pollutant concentration from a single point source as a function of atmospheric stability and wind speed.
- PTDIS, which computes short-term, ground level pollutant concentrations downwind from a point source for distances and stability classes chosen by the user.

Each of these models is included in the User's Network for Applied Modeling of Air Pollution (UNAMAP) available from EPA. The results from both models are considered valid for averaging times from ten minutes to an hour. If the source parameters and meteorological conditions are assumed to be constant, the modeled values can be converted to expected 24-hour averages by multiplying the former by 0.58.*

Two source configurations were modeled in the study:

- The existing operation, in which the pyrolysis boiler exhaust gases are water-scrubbed prior to passage over condenser tubes and then emitted from an 11.4 m (37.5 ft) by 7.6 m (25 ft) horizontal area.
- A proposed system consisting of an electrostatic precipitator and a 67.1 m (220 ft) stack.

The stack parameters used for the dispersion analysis are given (Table 7). Because the ground level concentration of each pollutant is proportional to its emission rate if all other factors are held constant, it was only

*See Turner, D. B., Workbook of Atmospheric Dispersion Estimates, 999-AP-26, U.S. Public Health Source, Revised 1969.

necessary to perform a set of diffusion runs for a single emission rate. Results for other emission rates were obtained by a simple ratio technique. For convenience, a rate of 100 grams per second (794 lb per hour) was used in every case.

TABLE 7. STACK PARAMETERS USED FOR DISPERSION ANALYSIS

PARAMETER	EXISTING	PROPOSED
Ambient Temperature	69°F	69°F
Source Strength	794 lb/hr*	794 lb/hr*
Stack Height	25 ft	220 ft
Stack Temperature	120°F	450°F
Volume Flow Rate	840,000 ACFM**	365,000 ACFM
Gas Velocity	900 ft/min	1800 ft/min

*This rate corresponds to 100 grams/sec which was chosen for convenience, as discussed in the text.

**This flow rate is based on the estimated dilution air in the water condensers.

The meteorological parameters used in the analysis were based on stability wind rose data for Baltimore Friendship International Airport. In order to get a broadly based perspective, five year average data for the period 1969 through 1973 were used. PTMAX requires no meteorological data, because it automatically makes calculations for all stability classes. For PTDIS, both "most probable" and "unfavorable" meteorological conditions were chosen as follows:

- Most probable conditions
  - stability class D (neutral) occurs almost 50% of the time, much more than any other single class.
  - under class D stability, the wind speed is between 4 knots and 16 knots 85% of the time.

- Unfavorable conditions
  - stability class F (highly stable) occurs 20% of the time, much more than any other stable class.
  - under stability class F, the wind speed is between 0 and 6 knots 100% of the time.

The average height of the mixing layer was chosen as 700 meters (2,297 feet) for the most probable cases and 300 meters (984 feet) for the unfavorable cases on the basis of information contained in Stern.* The meteorological data are summarized (Table 8).

TABLE 8. METEOROLOGICAL PARAMETERS USED FOR DISPERSION ANALYSIS

GENERAL CONDITIONS	STABILITY CLASS	WIND SPEED KNOTS (m/sec)	MIXING HEIGHT (m)
Most Probable	D	4 (2.1)	700
	D	8.5 (4.4)	700
	D	16 (8.2)	700
Unfavorable	F	2 (1.03)	300
	F	6 (3.09)	300

For PTDIS, the downwind distances at which concentration calculations are to be made must be specified. These were selected as 0.8 km (0.5 mile), 1.6 km (1.0 mile), 2.4 km (1.5 miles), 3.2 km (2 miles), 4.8 km (3 miles), 6.4 km (4 miles), 8.0 km (5 miles), 9.6 km (6 miles), 11.3 km (7 miles), and 12.9 km (8 miles), in accordance with a request from Mr. Don Andrew of Maryland BAQNC.

DISCUSSION OF RESULTS

The detailed results of the diffusion analysis are given in Appendix B. As noted earlier, these runs were made for a nominal emission rate of 100 grams per second, in order to minimize the number of computer runs required.

*Stern, Arthur C., Air Pollution, Volume I, Air Pollution and Its Effects, 2nd edition, Academic Press, New York, 1968.

To convert the data in the appendix to actual levels, the conversion factors below should be used:

Pollutant	Existing Conditions	Proposed Configuration
Particulate Matter	0.1937	0.0320
Sulfur Oxides	0.0252	0.2015
Nitrogen Oxides	0.0049	0.0049

The differences in these factors between the existing and proposed configurations reflect differences in the control equipment to be used:

- The existing scrubber removes SO_x quite well, but particulate removal is inadequate.
- The proposed electrostatic precipitator is assumed to meet the Maryland particulate matter emission standard (0.069 grams per standard cubic meter [0.03 grains per standard cubic foot] [dry]), but it is assumed to remove no SO_x or NO_x.

The predicted maximum one-hour ground level concentrations of each of the modeled pollutants are shown (Table 9). The values given are for the critical wind speed for each stability class, that is, the wind speed which gives the highest predicted ground level concentration. The downwind location of the maxima are also listed. The prominent features of these results are as follows:

1. Based on this analysis, no Maryland or Federal Air Quality Standards should be violated by the pyrolysis unit in their configuration. (It should be noted that no truly effective means for assessing the downwash problem of the existing configuration was available. Nevertheless, both Briggs and Turner have studied this phenomenon and a brief analysis is presented in Appendix C. The proposed configuration should completely alleviate this problem). However, during these tests of the "existing configuration," Maryland and Federal Particulate Emission Standards were exceeded.

TABLE 9. MAXIMUM ONE-HOUR GROUND LEVEL POLLUTANT CONCENTRATIONS AT THE CRITICAL WIND SPEED*

STABILITY CLASS	EXISTING CONFIGURATION					PROPOSED CONFIGURATION				
	WIND	LOCATION	PM	SO_x	NO_x	WIND	LOCATION	PM	SO_x	NO_x
A	3.0	0.41	36.8	4.8	0.9	3.0	0.54	2.7	17.0	0.4
B	5.0	0.59	33.0	4.3	0.8	5.0	1.07	1.7	10.4	0.3
C	15.0	0.35	68.2	8.9	1.7	15.0	1.00	1.7	10.5	0.3
D	20.0	0.49	66.4	8.7	1.7	20.0	2.37	0.9	5.5	0.1
E	2.0	4.45	36.7	4.8	0.9	2.0	12.43	1.2	7.3	0.2
F	2.0	8.30	32.8	4.3	0.8	2.0	39.04	0.4	2.8	0.1

*COMMENTS: (1) CONCENTRATION UNITS ARE MICROGRAMS PER CUBIC METER

(2) WIND SPEED IS METERS PER SECOND

(3) LOCATION IS THE DOWNWIND DISTANCE TO THE POINT OF MAXIMUM CONCENTRATION IN MILES

2. Except for SO_x, the proposed configuration shows greatly reduced maxima and they are further displaced from the source than is true for the existing system.

3. Although SO_x levels are somewhat increased for the proposed system--a result of eliminating the scrubber--they are still very low in comparison to the Maryland one-hour standard (920 $\mu g/m^3$).

The predicted one-hour average, ground level concentrations of the same three pollutants are shown (Tables 10 and 11) for the existing and proposed configurations, respectively. Again, there appear to be no particular air quality problems for either source arrangement. Concentrations of all three pollutants are greatly reduced in most cases for the proposed configuration in comparison with the existing system. The only exceptions are for SO_x at the 16 knot (8.2 m/sec) wind speed and distances of 3.2 km (2 miles) or more from the origin. The taller stack and higher wind speed move the point where the plume contacts the ground further downwind. The greater SO_x content of the proposed system accounts for most of the difference, however.

In summary, the results of this analysis indicate that the tall stack/electrostatic precipitator combination will alleviate the problem of downwash, which is the main drawback associated with the existing system. Although SO_x emissions are higher for the proposed system, they are still very low in comparison with local ambient standards.

Only the criteria (i.e., regulated) pollutants were considered in this analysis. However, one pollutant which could be of major concern in the design of the proposed electrostatic precipitator is chloride ion. If chloride is present in the form of particulate, the negatively charged chloride ion will aid the precipitators in capturing this particulate. If the chloride is present in the form of gaseous HCl (a likely possibility in the reducing atmosphere of the precipitator), the chloride will not be collected by the ESP. In this study, large amounts of chloride were found in the exhaust gas from the pyrolysis unit; however, a more detailed analysis is needed to determine whether the majority of the chloride was particulate or gaseous. In either case, care must be taken

TABLE 10. DOWNWIND POLLUTANT CONCENTRATIONS AT VARIOUS DISTANCES*

EXISTING SOURCE CONFIGURATION

DISTANCE (MILES)	POLLUTANT	PROBABLE CONDITIONS (D STABILITY)			UNFAVORABLE CONDITIONS (F STABILITY)	
		4 KNOTS	8.5 KNOTS	16 KNOTS	2 KNOTS	6 KNOTS
0.5	PM	0.0	0.0	2.6	0.0	0.0
	SO_x	0.0	0.0	0.3	0.0	0.0
	NO_x	0.0	0.0	0.1	0.0	0.0
1.0	PM	0.0	0.0	22.0	0.0	0.0
	SO_x	0.0	0.0	2.9	0.0	0.0
	NO_x	0.0	0.0	0.6	0.0	0.0
1.5	PM	0.0	3.6	26.6	0.0	2.8
	SO_x	0.0	0.5	3.5	0.0	0.4
	NO_x	0.0	0.1	0.7	0.0	0.1
2.0	PM	0.0	7.4	24.6	0.0	8.8
	SO_x	0.0	1.0	3.2	0.0	1.1
	NO_x	0.0	0.2	0.6	0.0	0.2
3.0	PM	0.0	11.2	18.4	3.3	20.3
	SO_x	0.0	1.5	2.4	0.4	2.6
	NO_x	0.0	0.3	0.5	0.1	0.5
4.0	PM	0.1	11.8	13.9	9.0	27.9
	SO_x	0.0	1.5	1.8	1.2	3.6
	NO_x	0.0	0.3	0.4	0.2	0.7
5.0	PM	0.1	11.0	10.8	14.9	31.3
	SO_x	0.0	1.4	1.4	1.9	4.1
	NO_x	0.0	0.3	0.3	0.4	0.8
6.0	PM	2.3	10.0	8.7	19.8	32.2
	SO_x	0.3	1.3	1.1	2.6	4.2
	NO_x	0.1	0.3	0.2	0.5	0.8
7.0	PM	2.9	8.9	7.2	23.9	32.1
	SO_x	0.4	1.2	0.9	3.1	4.2
	NO_x	0.1	0.2	0.2	0.6	0.8
8.0	PM	3.4	8.0	6.1	27.0	31.9
	SO_x	0.4	1.0	0.8	3.5	4.2
	NO_x	0.1	0.2	0.2	0.7	0.8

*CONCENTRATIONS IN MICROGRAMS PER CUBIC METER

TABLE 11. DOWNWIND POLLUTANT CONCENTRATIONS AT VARIOUS DISTANCES*

PROPOSED SOURCE CONFIGURATION

DISTANCE (MILES)	POLLUTANT	PROBABLE CONDITIONS (D STABILITY)			UNFAVORABLE CONDITIONS (F STABILITY)	
		4 KNOTS	8.5 KNOTS	16 KNOTS	2 KNOTS	6 KNOTS
0.5	PM	0.0	0.0	0.0	0.0	0.0
	SO_x	0.0	0.0	0.0	0.0	0.0
	NO_x	0.0	0.0	0.0	0.0	0.0
1.0	PM	0.0	0.0	0.0	0.0	0.0
	SO_x	0.0	0.0	0.0	0.0	0.0
	NO_x	0.0	0.0	0.0	0.0	0.0
1.5	PM	0.0	0.0	0.0	0.0	0.0
	SO_x	0.0	0.0	0.0	0.0	0.0
	NO_x	0.0	0.0	0.0	0.0	0.0
2.0	PM	0.0	0.0	0.0	0.0	0.0
	SO_x	0.0	0.0	0.1	0.0	0.0
	NO_x	0.0	0.0	0.0	0.0	0.0
3.0	PM	0.0	0.0	0.5	0.0	0.0
	SO_x	0.0	0.0	3.0	0.0	0.0
	NO_x	0.0	0.0	0.1	0.0	0.0
4.0	PM	0.0	0.0	0.6	0.0	0.0
	SO_x	0.0	0.1	3.9	0.0	0.0
	NO_x	0.0	0.0	0.1	0.0	0.0
5.0	PM	0.0	0.0	0.7	0.0	0.0
	SO_x	0.0	0.1	4.1	0.0	0.0
	NO_x	0.0	0.0	0.1	0.0	0.0
6.0	PM	0.0	0.0	0.6	0.0	0.0
	SO_x	0.0	0.2	4.0	0.0	0.0
	NO_x	0.0	0.0	0.1	0.0	0.0
7.0	PM	0.0	0.3	0.6	0.0	0.0
	SO_x	0.0	2.1	3.8	0.0	0.1
	NO_x	0.0	0.1	0.1	0.0	0.0
8.0	PM	0.0	0.4	0.6	0.0	0.0
	SO_x	0.0	2.3	3.5	0.0	0.1
	NO_x	0.0	0.1	0.1	0.0	0.0

*CONCENTRATIONS IN MICROGRAMS PER CUBIC METER

in selecting the materials for the construction of the precipitator, since chloride ion is a highly corrosive substance. Wet electrostatic precipitators, which use a continuous stream of water to remove particulate from the collection plates, have shown some success in removing these acid mists.

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-15-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE Part.
RUN NUMBER PPE-1
OPERATOR Mc R
AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 29.91
STATIC PRESSURE, (P_s) +7 -.0"
FILTER NUMBER(s) 520.6571

PROBE LENGTH AND TYPE 10' S.S.
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 8
METER ΔH 2.00
C FACTOR .90
PROBE HEATER SETTING 70
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min. / Clock Time (24 hr Clock)		Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0	1540	838.755									
A-1	5	45	842.01	.42	1.4	1.4	135	60	50	14	250	50
A-2	10	50	845.50	.65	2.1	2.1	135	68	52	4	250	50
A-3	15	55	848.70	.55	1.8	1.8	140	72	54	4	250	50
A-4	20	1600	853.60	.85	2.8	2.8	140	82	60	6	250	50
A-5	25	05	857.40	.90	2.9	2.9	140	82	62	5	250	50
A-6	30	1610	862.04	.80	2.6	2.6	140	84	62	5	250	50
	STOP			PORT CHANGE								
	START 1630		862.04									
B-1	35	35	865.00	.50	1.7	1.7	135	72	62	5	250	50
B-2	40	40	868.20	.45	1.5	1.5	140	76	62	4	250	50
B-3	45	45	872.20	.65	2.1	2.1	140	80	64	4	250	50
B-4	50	50	874.00	.60	2.0	2.0	140	80	64	7	250	50
B-5	55	55	876.90	.65	2.1	2.1	140	82	66	7	250	50
B-6	60	1700	880.60	.65	2.1	2.1	140	82	66	15	250	50
	60		41.845			2.1		68.5				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE Part.
RUN NUMBER PPE-2
OPERATOR Mc R
AMBIENT TEMPERATURE 45
BAROMETRIC PRESSURE 30.16
STATIC PRESSURE, (P_s) +7"
FILTER NUMBER(s) 516.6542

PROBE LENGTH AND TYPE 10' S.S.
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 8
METER ΔH 1.90
C FACTOR .90
PROBE HEATER SETTING 70
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0	1120	881.74									
A-1	5	25	884.80	.35	1.2	1.2	135	62	50	2	250	55
A-2	10	30	887.50	.35	1.2	1.2	140	66	52	3	250	55
A-3	15	35	890.70	.40	1.3	1.3	140	70	54	3	250	55
A-4	20	40	893.50	.50	1.65	1.65	140	72	54	5	250	55
A-5	25	45	897.10	.45	1.5	1.5	140	74	56	5	250	55
A-6	30	1150	899.75	.40	1.3	1.3	140	78	60	5	250	55
	STOP			PORT CHANGE								
	START	1210	899.75									
B-1	35	15	902.15	.25	.83	.83	135	66	58	2	250	60
B-2	40	20	905.10	.40	1.3	1.3	140	74	60	4	250	60
B-3	45	25	908.30	.45	1.5	1.5	140	78	62	5	250	60
B-4	50	30	911.35	.50	1.65	1.65	140	80	62	5	250	60
B-5	55	35	914.80	.50	1.65	1.65	140	80	64	5	250	60
B-6	60	1240	917.685	.50	1.65	1.65	140	80	64	5	250	60
	60		35.945			1.39		65.7				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE Part.
RUN NUMBER PPE-3
OPERATOR Mc R
AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 30.16
STATIC PRESSURE, (P_s) +7"
FILTER NUMBER(s) 533.6581

PROBE LENGTH AND TYPE 10' S.S.
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 8
METER ΔH 1.90
C FACTOR .90
PROBE HEATER SETTING 70
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min. / Clock Time (24 hr Clock)		Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0	1440	918.44									
B-1	5	45	920.50	.25	.83	.83	135	62	52	2	250	55
B-2	10	50	923.40	.40	1.3	1.3	140	64	52	3	250	55
B-3	15	55	926.30	.45	1.5	1.5	140	70	54	6	250	55
B-4	20	1500	929.70	.50	1.65	1.65	140	72	56	7	250	55
B-5	25	05	932.70	.50	1.65	1.65	140	78	58	10	250	55
B-6	30	10	936.42	.50	1.65	1.65	140	80	60	8	250	55
	STOP			PORT CHANGE								
	START	1525	936.42									
A-1	35	30	939.30	.35	1.2	1.2	135	70	60	1	250	55
A-2	40	35	942.20	.35	1.2	1.2	140	74	60	1	250	55
A-3	45	40	945.10	.40	1.3	1.3	140	76	60	2	250	55
A-4	50	45	948.40	.50	1.65	1.65	140	78	62	2	250	55
A-5	55	50	951.30	.45	1.5	1.5	140	80	62	2	250	55
A-6	60	1555	954.20	.40	1.3	1.3	140	80	62	2	250	55
	60		35.76			1.39		65.9				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-15-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE SOX
RUN NUMBER PSE-1
OPERATOR Mc R
AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 29.91
STATIC PRESSURE, (P_s) +2.0"
FILTER NUMBER(s) –

PROBE LENGTH AND TYPE 5' S.S.
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 4
METER ΔH 1.87
C FACTOR .9
PROBE HEATER SETTING 60
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0	1537	814.19									
C-1	5	42	817.25	.45	1.5	1.5	135	54	48	8	250	50
C-1	10	47	820.60	.42	1.4	1.4	135	62	50	8	250	50
C-1	15	52	823.40	.42	1.4	1.4	135	66	50	11	250	50
C-1	20	57	826.60	.40	1.3	1.35	140	72	54	10	250	50
C-1	25	1602	830.25	.40	1.3	1.35	140	72	54	10	250	50
C-1	30	07	832.75	.40	1.3	1.35	140	74	54	10	250	50
C-1	35	12	836.00	.40	1.3	1.35	140	76	56	10	250	50
C-1	40	17	837.30	.37	1.2	1.25	140	76	56	10	250	50
C-1	45	22	841.90	.37	1.2	1.25	140	76	58	10	250	50
C-1	50	27	845.20	.42	1.4	1.4	140	76	58	10	250	50
C-1	55	32	848.30	.42	1.4	1.4	140	78	58	10	250	50
C-1	61	1637	851.80	.42	1.4	1.4	140	78	58	10	250	50
	61		37.61			1.37		63.1				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE SO_x
RUN NUMBER PSE-2
OPERATOR Mc R
AMBIENT TEMPERATURE 45
BAROMETRIC PRESSURE 30.25
STATIC PRESSURE, (P_s) +7"
FILTER NUMBER(s) –

PROBE LENGTH AND TYPE 5' Glass
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 4
METER ΔH 1.87
C FACTOR .70
PROBE HEATER SETTING 70
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min. / Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
				Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0 / 1113	852.105									
C-1	5 / 18	855.05	.40	1.3	1.3	140	54	46	5	250	50
C-1	10 / 23	857.83	.40	1.3	1.3	140	58	48	6	250	55
C-1	15 / 28	860.80	.40	1.3	1.3	140	62	50	6	250	60
C-1	20 / 33	863.65	.40	1.3	1.3	140	64	52	8	250	60
C-1	25 / 38	866.60	.40	1.3	1.3	140	64	52	9	250	60
C-1	30 / 43	869.60	.40	1.3	1.3	140	66	54	10	250	60
C-1	35 / 48	872.50	.40	1.3	1.3	140	68	54	11	250	60
C-1	40 / 53	875.40	.40	1.3	1.3	140	68	54	11	250	60
C-1	45 / 58	878.50	.40	1.3	1.3	140	68	54	12	250	60
C-1	50 / 1203	881.20	.40	1.3	1.3	140	70	54	12	250	60
C-1	55 / 08	884.15	.40	1.3	1.3	140	70	56	12	250	70
C-1	60 / 1213	887.025	.40	1.3	1.3	140	68	56	12	250	70
	60	34.92			1.30		58.8				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE SO_x
RUN NUMBER PSE-3
OPERATOR Mc R
AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 30.16
STATIC PRESSURE, (P_s) +7"
FILTER NUMBER(s) –

PROBE LENGTH AND TYPE 5' Glass
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 4
METER ΔH 1.87
C FACTOR .90
PROBE HEATER SETTING 60
HEATER BOX SETTING 250
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	0	1452	887.70									
C-1	5	57	890.60	.40	1.3	1.3	140	54	48	6	250	55
C-1	10	1502	893.40	.40	1.3	1.3	140	56	48	6	250	55
C-1	15	07	896.40	.40	1.3	1.3	140	60	50	6	250	55
C-1	20	12	899.30	.40	1.3	1.3	140	62	50	8	250	55
C-1	25	17	902.30	.40	1.3	1.3	140	64	52	8	250	55
C-1	30	22	905.40	.40	1.3	1.3	140	64	52	8	250	55
C-1	35	27	908.40	.40	1.3	1.3	140	64	52	8	250	55
C-1	40	32	911.50	.40	1.3	1.3	140	66	54	8	250	55
C-1	45	37	914.60	.40	1.3	1.3	140	66	54	8	250	55
C-1	50	42	917.60	.40	1.3	1.3	140	66	56	8	250	55
C-1	55	47	920.60	.40	1.3	1.3	140	66	56	8	250	55
C-1	60	1552	923.53	.40	1.3	1.3	140	68	59	8	250	55
	60		35.83			1.3		57.8				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-15-76
SAMPLING LOCATION Inlet
SAMPLE TYPE SO_2/SO_3
RUN NUMBER PSI-1
OPERATOR MWH
AMBIENT TEMPERATURE 65°
BAROMETRIC PRESSURE 29.91
STATIC PRESSURE, (P_s) -1"
FILTER NUMBER(s)

PROBE LENGTH AND TYPE 5' Pyrex
NOZZLE I.D. .250
ASSUMED MOISTURE, % 6
SAMPLE BOX NUMBER —
METER BOX NUMBER New
METER ΔH 2.00 (1.92)
C FACTOR 1.1
PROBE HEATER SETTING 70°
HEATER BOX SETTING 350°
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	000	1535	886.60									
A-1	05	1540	890.50	.60	2.4	2.4	120	84	80	12	300	50
A-1	10	1545	894.30	.60	2.4	2.4	120	88	81	15	300	50
A-1	15	1550	896.20	.70	.42	.42	120	88	82	3	300	50
A-1	20	1555	899.90	.60	2.4	2.4	120	88	82	15	300	50
A-1	25	1600	903.80	.65	2.6	2.6	120	99	84	20	300	50
A-1	30	1605	907.30	.60	2.4	2.4	120	100	88	20	300	50
A-1	35	1610	911.50	.60	2.4	2.4	120	99	88	20	300	50
A-1	40	1615	915.20	.50	1.95	1.95	120	96	88	17	300	50
A-1	45	1620	919.60	.50	1.95	1.95	120	90	86	17	300	50
A-1	50	1625	922.73	.50	1.95	1.95	120	91	85	17	300	50
A-1	55	1630	926.25	.50	1.95	1.95	120	96	86	18	300	50
A-1	60	1635	931.95	.50	2.4	2.4	120	98	87	21	300	50
	60		45.35			2.10		88.9				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Inlet
SAMPLE TYPE SO_x
RUN NUMBER PSI-2
OPERATOR MWH
AMBIENT TEMPERATURE 70°
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) -6" H_2O
FILTER NUMBER(s)

PROBE LENGTH AND TYPE 5' Pyrex
NOZZLE I.D. .250
ASSUMED MOISTURE, % 8
SAMPLE BOX NUMBER New
METER BOX NUMBER New
METER ΔH 1.92
C FACTOR 1.0
PROBE HEATER SETTING 80
HEATER BOX SETTING 300°
REFERENCE Δp .72

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	000	1115	937.80									
Same	05	1120	941.65	.45	1.25	1.25	400	71	83	6.0	300	50
	10	1125	944.30	.50	1.40	1.40	420	79	83	7.0	300	50
	15	1130	947.80	.40	1.05	1.05	420	82	82	7.0	300	50
	20	1135	950.425	.60	1.55	1.55	420	85	83	10.0	300	50
	25	1140	953.20	.45	1.20	1.20	420	89	84	9.5	300	50
	30	1145	956.10	.45	1.20	1.20	420	86	84	9.5	300	50
	35	1150	959.43	.45	1.20	1.20	420	87	85	10.5	300	50
	40	1155	962.09	.40	1.05	1.05	420	87	85	10.0	300	50
	45	1200	965.30	.60	1.55	1.55	420	88	87	14.0	300	50
	50	1205	968.10	.40	1.05	1.05	420	90	88	11.0	300	50
	55	1210	971.10	.50	1.30	1.30	430	89	87	12.0	300	50
	60	1215	973.90	.40	1.05	1.05	430	89	88	11.0	300	50
	60		36.10			1.24		85.0				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-16-76
SAMPLING LOCATION Inlet
SAMPLE TYPE SO_x
RUN NUMBER PSI-3
OPERATOR MWH
AMBIENT TEMPERATURE 70°
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) -8" H_2O
FILTER NUMBER(s)

PROBE LENGTH AND TYPE 5' Pyrex
NOZZLE I.D. .250
ASSUMED MOISTURE, % 6
SAMPLE BOX NUMBER New
METER BOX NUMBER New
METER ΔH 1.92
C FACTOR 1.0
PROBE HEATER SETTING 75
HEATER BOX SETTING 300
REFERENCE Δp .72

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Traverse Point Number	Sampling Time, min. / Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
				Desired	Actual		Inlet (Tm_{in}), °F	Outlet (Tm_{out}), °F			
	000 / 1450	974.491									
Same	05 / 1455	978.35	1.0	2.50	2.50	420	65	72	14.0	300	50
	10 / 1500	982.80	1.0	2.50	2.50	450	77	72	15.0	300	50
	15 / 1505	986.90	1.0	2.50	2.50	450	87	75	20.0	300	50
	20 / 1510	991.60	1.0	2.50	2.50	450	94	79	16.0	300	50
	25 / 1515	994.70	1.1	2.75	2.75	450	94	81	20.0	300	50
	30 / 1520	999.90	1.1	2.75	2.75	450	94	83	20.0	300	50
	35 / 1525	1003.95	1.1	2.75	2.60	450	91	84	20.0	300	50
	40 / 1530	1008.20	1.1	2.75	2.50	450	88	82	21.0	300	50
	45 / 1535	1012.10	1.2	3.00	2.50	470	89	83	21.0	300	50
	50 / 1540	1016.20	1.1	2.75	2.30	470	90	82	21.0	300	50
	55 / 1545	1020.00	1.1	2.75	2.30	470	90	83	21.0	300	50
Stop	60 / 1550	1023.75	1.1	2.75	2.75	470	90	83	21.0	300	50
	60	49.259			2.54		83.7				

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-17-76
SAMPLING LOCATION Inlet
SAMPLE TYPE Trace Metals & Hydrocarbons
RUN NUMBER PPIN-1
OPERATOR MWH
AMBIENT TEMPERATURE 65°
BAROMETRIC PRESSURE 30.20
STATIC PRESSURE, (P_s) -8" H_2O
FILTER NUMBER(s) –

PROBE LENGTH AND TYPE 5' Pyrex
NOZZLE I.D. .250
ASSUMED MOISTURE, % 6
SAMPLE BOX NUMBER New
METER BOX NUMBER New
METER ΔH 1.92
C FACTOR 1.0
PROBE HEATER SETTING 80°
HEATER BOX SETTING 350
REFERENCE Δp .72

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5-10 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	000	1210	161.20									
A-1	05	1215	165.20	.85	3.0	3.0		60	58	8.0	300	50
A-1	10	1220	169.40	.75	3.0	3.0		68	59	8.0	300	50
A-1	15	1225	173.70	.70	3.0	3.0		77	60	8.0	300	50
A-1	20	1230	177.00	.70	3.0	3.0		79	62	8.0	300	50
A-1	25	1235	181.50	.75	3.0	3.0		78	63	8.0	300	50
A-1	30	1240	186.00	.75	3.0	3.0		79	64	8.0	300	50
A-1	35	1245	190.30	.75	3.0	3.0		78	64	8.0	300	50
A-1	40	1250	194.50	.75	3.0	3.0		75	64	8.0	300	50
A-1	45	1255	198.90	.75	3.0	3.0		75	64	8.0	300	50
A-1	50	1300	203.50	.75	3.0	3.0		75	64	8.0	300	50
A-1	55	1305	207.60	.75	3.0	3.0		75	63	8.0	300	50
A-1	60	1310	211.80	.75	3.0	3.0		76	63	8.0	300	50
A-1	70	1320	220.20	.75	3.0	3.0		77	64	8.5	300	50
A-1	80	1330	227.95	.75	3.0	3.0		78	64	9.0	300	50
A-1	90	1340	236.40	.68	2.2	2.2		79	64	9.0	300	50
A-1	100	1350	244.70	.70	3.0	3.0		80	65	9.0	300	50
A-1	110	1400	252.40	.70	3.0	3.0		80	65	9.0	300	50
A-1	120	1410	261.35	.70	3.0	3.0		83	67	15.0	300	50
A-1	130	1420	271.35	.76	3.0	3.0		82	67	15.0	300	50
A-1	140	1430	279.02	.70	3.0	3.0		82	67	15.0	300	50
A-1	150	1440	288.70	.70	3.0	3.0		80	66	15.0	300	50
A-1	160	1450	300.40	.70	3.0	3.0		78	65	15.0	300	50
A-1	170	1500	302.60	.70	3.0	3.0		78	65	15.0	300	50

Traverse Point Number	Sampling Time, min. / Clock Time (24 hr Clock)		Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
			302.60									
A-1	180	1510	310.80	.70	2.5	2.5		79	66	20.0	300	50
A-1	190	1520	318.40	.70	2.5	2.5		79	66	20.0	300	50
A-1	200	1530	325.70	.70	2.5	2.5		78	66	20.0	300	50
A-1	210	1540	332.40	.70	2.0	2.0		79	66	20.0	300	50
A-1	220	1550	339.90	.70	2.0	2.0		83	69	20.0	300	50
A-1	230	1600	346.80	.70	2.0	2.0		83	70	20.0	300	50
A-1	240	1610	354.40	.70	2.0	2.0		84	71	20.0	300	50
A-1	250	1620	361.20	.70	1.0	1.0		84	71	20.0	300	50
A-1	260	1630	367.40	.70	1.0	1.0		92	78	20.0	300	50
A-1	270	1640	373.50	.70	1.0	1.0		92	78	20.0	300	50
			STOP		END TEST							

FIELD DATA

PLANT Baltimore Pyrolysis
DATE 11-17-76
SAMPLING LOCATION Exhaust
SAMPLE TYPE Trace Metal & Hydrocarbons
RUN NUMBER PPEX-1
OPERATOR Henry
AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 30.20
STATIC PRESSURE, (P_s) +7"
FILTER NUMBER(s) –

PROBE LENGTH AND TYPE 5' Pyrex
NOZZLE I.D. 1/4
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER –
METER BOX NUMBER 9
METER ΔH 2.00
C FACTOR .90
PROBE HEATER SETTING 70°
HEATER BOX SETTING 300
REFERENCE Δp .56

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5-10 MINUTES

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
	000		348.549									
A-1	05	1220	349.895	.45	3.6	3.6		58	52	10	250	50
A-1	10	25	354.000	.44	3.5	3.5		64	52	10	250	50
A-1	15	30	358.145	.45	3.6	3.6		72	55	16	250	50
A-1	20	35	363.215	.45	3.6	3.6		82	59	,5	250	50
A-1	25	40	368.245	.45	3.6	3.6		84	61	5	250	50
A-1	30	45	373.215	.45	3.6	3.6		84	64	5	250	50
A-1	35	50	378.008	.45	3.6	3.6		84	64	5	250	50
A-1	40	55	382.725	.40	3.2	3.2		85	65	5	250	50
A-1	45	1300	387.285	.42	3.3	3.3		86	67	5	250	50
A-1	STOP		NEW BOTTLE – RESTART TEST									
A-1	START		397.010	.41	3.2	3.2		80	64	5	250	50
A-1	50	1340	397.455	.41	3.2	3.2		81	64	5	250	50
A-1	55	45	405.825	.41	3.2	3.2		81	64	5	250	50
A-1	60	50	410.315	.42	3.3	3.3		81	64	5	250	50
A-1	70	1400	419.625	.43	3.3	3.3		81	64	5	250	50
A-1	80	10	429.215	.43	3.3	3.3		82	67	5	250	50
A-1	90	20	437.310	.48	3.8	3.8		86	70	7	250	50
A-1	100	30	442.575	.48	3.8	3.8		84	73	20	250	50
A-1	STOP		CHANGE FILTER – CLOGGED – CONTINUE TEST									
A-1	START		446.255									
A-1	110	1505	457.545	.48	3.8	3.8		80	70	5	250	50
A-1	130	1515	469.355	.65	4.2	4.2		100	79	5	250	50
A-1	130	25	478.565	.65	4.2	4.2		88	78	5	250	50

Traverse Point Number	Sampling Time, min.	Clock Time (24 hr Clock)	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), n, H_2O		Stack Temperature (T_s), °F	Dry Gas Meter Temperature		Pump Vacuum, in. Hg	Sample Box Temperature, °F	Impinger Temperature, °F
					Desired	Actual		Inlet ($T_{m_{in}}$), °F	Outlet ($T_{m_{out}}$), °F			
			478.565									
A-1	140	1535	490.135	.68	4.2	4.2		88	75	5	250	50
A-1	150	45	501.185	.68	4.2	4.2		90	74	6	250	50
A-1	160	55	511.605	.60	4.0	4.0		72	74	6	250	50
A-1	170	1605	522.035	.60	4.0	4.0		96	78	7	250	50
A-1	180	15	533.350	.55	3.7	3.7		99	83	7	250	50
A-1	190	25	544.465	.55	3.7	3.7		100	88	7	250	50
A-1	200	35	555.015	.55	3.7	3.7		100	88	7	250	50
A-1	210	45	565.275	.55	3.7	3.7		102	89	8	250	50
A-1	220	55	575.515	.55	3.7	3.7		110	95	9	250	50
A-1	230	1705	585.475	.55	3.7	3.7		110	96	9	250	50
A-1	240	15	595.305	.65	4.2	4.2		114	105	10	250	50
A-1	250	25	605.315	.55	3.7	3.7		114	103	10	250	50
	STOP				END TEST							

NO_x FIELD SAMPLING DATA

DATE Nov. 15, 1976

SAMPLE NO.	SAMPLE TIME	FLASK #/VOMUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
PNE-1	3:40	20/2100	44	38	25"	-0.8"	29.91	30.20	11/16 0930
PNE-2	4:20	25/2102	44	38	25"	-0.5"	29.91	30.20	11/16 0930
PNI-1	4:00	22/2114	44	40	25"	-1.5"	29.91	30.20	11/16 0930
PNI-2	4:15	/2116	44	40	25"	- 1.0"	29.91	30.20	11/16 0930

2116 – appeared to be less than 25" vacuum intake.

NOTES:

NO_x FIELD SAMPLING DATA

DATE Nov. 16, 1976

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
PNI-3	11:52	17/2094	52	38	26"	-1.1"	30.2	30.26	11/17 1000
PNE-3	11:38	21/2110	52	38	30"	-3.7"	30.2	30.26	11/17 1000
PNI-4	12:22	24/2109	52	38	25"	-3.8"	30.2	30.26	11/17 1000
PNE-4	12:15	19/2122	52	38	25.5"	-2.4"	30.2	30.26	11/17 1000

NOTES:

NO_x FIELD SAMPLING DATA

DATE Nov. 16, 1976

SAMPLE NO.	SAMPLE TIME	FLASK #/VOMUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
PNI-5	12:45	20/2100	60	38	25"	-3.1"	30.2	30.26	11/17 1000
PNE-5	12:30	23/2116	60	38	25"	-1.2"	30.2	30.26	11/17 1000
PNI-6	12:50	22/2114	54	38	25"	- .2"	30.2	30.26	11/17 1000
PNE-6	12:55	25/2102	54	38	25"	- .5"	30.2	30.26	11/17 1000

NOTES:

NO_x FIELD SAMPLING DATA

DATE Nov. 16, 1976

SAMPLE NO.	SAMPLE TIME	FLASK #/VOMUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
PNI-7	14:50	4/2089	50	38	26"	-3.3"	30.15	30.26	11/17 1000
PNE-7	14:56	9/2083	50	38	25.5"	-2.7	30.15	30.26	11/17 1000
PNI-8	14:30	12/2088	50	38	26.5"	-3.6"	30.15	30.26	11/17 1000
PNE-8	15:36	11/2090	50	38	26"	-1.9"	30.15	30.26	11/17 1000
PNI-9	16:25	6/2084	50	38	27.5"	-1.9"	30.15	30.26	11/17 1000
PNE-9	16:10	15/2100	50	38	28.0"	- .1"	30.15	30.26	11/17 1000

NOTES:

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/15/76

Plant Baltimore Pyrolysis Location INLET

Bar. Pressure 29.91 "Hg Comments:

Ambient Temp. 70 °F

Run No. PGI-1

Power Stat Setting 80

Filter Used: Yes _____ No x

Operator MWH

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
Start 15:48	273.125	2.0	74°
15:53	273.480	2.0	74°
15:58	273.800	2.0	78°
16:03	274.185	2.0	78°
16:08	274.480	2.0	80°
16:13	274.770	2.0	80°
Stop 16:18	275.025	2.0	80°
30	1.900		77.7°

Comments:

Impinger Bucket No. _____

Meter Box No. G-1

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/16/76

Plant Baltimore Pyrolysis Location INLET

Bar. Pressure 30.25 "Hg Comments:

Ambient Temp. 70 °F

Run No. PGI-2

Power Stat Setting 90

Filter Used: Yes ____ No x

Operator MWH

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
11:11	276.62	.5	70°
Start 11:18	276.765	2.0	70°
11:23	277.120	2.0	70°
11:28	277.400	2.0	70°
11:33	277.600	2.0	70°
11:38	277.840	2.0	70°
11:43	278.120	2.0	70°
Stop 11:48	278.325	2.0	70°
30	1.705		70°

Comments:

Impinger Bucket No. ____

Meter Box No. G-1

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/16/76

Plant Baltimore Pyrolysis

Location INLET

Bar. Pressure 30.16 "Hg

Comments:

Ambient Temp. 70 °F

Run No. PGI-3

Power Stat Setting 85

Filter Used: Yes ____ No x

Operator MWH

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
Start 14:59	279.625	2.0	79°
15:04	279.970	2.0	79°
15:09	280.260	2.0	79°
15:14	280.480	2.0	79°
15:19	281.00	2.0	79°
15:24	281.30	2.0	79°
Stop 15:29	281.70	2.0	79°
30	2.075		79°

Comments:

Impinger Bucket No. ____

Meter Box No. G-1

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/15/76

Plant Baltimore Pyrolysis **Location** Exhaust

Bar. Pressure 29.91 "Hg **Comments:**

Ambient Temp. 50 °F

Run No. PGE-1

Power Stat Setting 40

Filter Used: Yes____ No x

Operator McR

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
Start 16:14	204.100	1.5	46°
Stop 16:44	205.055	1.0	50°
30	.955		48°

Comments:

Impinger Bucket No. _____

Meter Box No. G-2

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/16/76

Plant Balitmore Pyrolysis

Location Exhaust

Bar. Pressure 30.25 "Hg

Comments:

Ambient Temp. 45 °F

Run No. PGE-2

Power Stat Setting 40

Filter Used: Yes ____ No x

Operator McR

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
Start 12:32	205.225	2.0	48°
Stop 13:02	205.855	.5	52°
30	0.63		50°

Comments:

Impinger Bucket No. ____

Meter Box No. G-2

GAS SAMPLING FIELD DATA

Material Sampled for TOTAL ACIDS

Date 11/16/76

Plant Balitmore Pyrolysis

Location Exhaust

Bar. Pressure 30.16 "Hg

Comments:

Ambient Temp. 50 °F

Run No. PGE-3

Power Stat Setting 50

Filter Used: Yes ____ No x

Operator McR

CLOCK TIME	METER ($Ft.^3$)	FLOW METER SETTING (LPM)	METER TEMPERATURE IN
Start 16:05	206.032	2.0	48°
Stop 16:35	208.800	2.0	55°
30	2.768		51.5°

Comments:

Impinger Bucket No. ____

Meter Box No. G-2

ANALYTICAL DATA

PLANT Baltimore Pyrolysis

DATE 11-19-76

SAMPLING LOCATION Exhaust

SAMPLE TYPE Part.

RUN NUMBER PPE-2

SAMPLE BOX NUMBER

CLEAN-UP MAN Mc R

COMMENTS:

FRONT HALF

ACETONE WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER

FILTER NUMBER	
	8552
	6542
	2010

LABORATORY RESULTS

CONTAINER ____ 186.4 mg

CONTAINER ____ 201.0 mg

FRONT HALF SUBTOTAL 387.4 mg

BACK HALF

IMPINGER CONTENTS AND WATER WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

ACETONE WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

CONTAINER ____ ____ mg

ETHER-CHLOROFORM EXTRACTION ____ mg

CONTAINER ____ ____ mg

BACK HALF SUBTOTAL ____ mg

TOTAL WEIGHT 387.4 mg

MOISTURE

IMPINGERS

FINAL VOLUME	424	ml
INITIAL VOLUME	300	ml
NET VOLUME	124	ml

SILICA GEL

FINAL WEIGHT	215.9	g	____	g	____	g
INITIAL WEIGHT	200.0	g	____	g	____	g
NET WEIGHT	15.9	g	____	g	____	g

TOTAL MOISTURE 139.9 g

ANALYTICAL DATA

PLANT Baltimore Pyrolysis

DATE 11-19-76

SAMPLING LOCATION Exhaust

SAMPLE TYPE Part

RUN NUMBER PPE-1

SAMPLE BOX NUMBER

CLEAN-UP MAN Mc R

COMMENTS:

FRONT HALF

LABORATORY RESULTS

ACETONE WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER

CONTAINER _____ 465.6 mg

FILTER NUMBER	
	.7752
	.6571
	.1181

CONTAINER _____ 118.1 mg

FRONT HALF SUBTOTAL 583.7 mg

BACK HALF

IMPINGER CONTENTS AND WATER WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

CONTAINER _____ _____ mg

ETHER-CHLOROFORM EXTRACTION _____ mg

ACETONE WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

CONTAINER _____ _____ mg

BACK HALF SUBTOTAL _____ mg

TOTAL WEIGHT 583.7 mg

MOISTURE

IMPINGERS

FINAL VOLUME	305 ml		
INITIAL VOLUME	200 ml		
NET VOLUME	105 ml		

SILICA GEL

FINAL WEIGHT	219.9 g	____ g	____ g
INITIAL WEIGHT	200.0 g	____ g	____ g
NET WEIGHT	19.9 g	____ g	____ g

TOTAL MOISTURE 124.9 g

ANALYTICAL DATA

PLANT Baltimore Pyrolysis

DATE 11-19-76

SAMPLING LOCATION Exhaust

SAMPLE TYPE Part.

RUN NUMBER PPE-3

SAMPLE BOX NUMBER

CLEAN-UP MAN Mc R

COMMENTS:

FRONT HALF

ACETONE WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER

	LABORATORY RESULTS
CONTAINER	209.3 mg
CONTAINER	170.2 mg

FILTER NUMBER	
	.8283
	.6581
	.1702

FRONT HALF SUBTOTAL 379.5 mg

BACK HALF

IMPINGER CONTENTS AND WATER WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

ACETONE WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER

CONTAINER	mg
ETHER-CHLOROFORM EXTRACTION	mg
CONTAINER	mg
BACK HALF SUBTOTAL	mg
TOTAL WEIGHT	379.5 mg

MOISTURE

IMPINGERS

FINAL VOLUME	300 ml
INITIAL VOLUME	200 ml
NET VOLUME	100 ml

SILICA GEL

FINAL WEIGHT	214.6 g	g	g
INITIAL WEIGHT	200 g	g	g
NET WEIGHT	14.6 g	g	g

TOTAL MOISTURE 114.6 g

LOAD SHEET
STACK TEST – PARTICULATE

Test # PPE-1

Part 1

Enter	(Initially Only)	
	Value	Location
	0.0283	04
	17.71	05
	0.0474	06
	1032	07

Test # PPE-2

Enter	Value	Location
Tf(Min)	60	09
$(DN)^2 (in^2)$	.0625	10
PS(in Hg)	30.67	11
$VM(ft^3)$	35.945	12
VW(ml)	139.9	13
% CO_2	9.5	14
% O_2	11.4	15
% N_2	79.1	16
$4350\sqrt{\ }$	68780.66	17
$As(ft^2)$	50.26	18
(Ts+460)	599.2	19
	Part 2	
mf (mg)	387.4	00
mt (mg)	387.4	01
$VMSTD(f^3)$	36.645	02
Ps ("Hg)	30.67	03
Md	.847	04
(Ts+460)	599.2	05
Qs(scfm)	90,321.1	06

Test # PPE-3

Enter	Value	Location
Tf(Min)	60	09
$(DN)^2 (in^2)$	.0625	10
PS(in Hg)	30.67	11
$VM(ft^3)$	35.760	12
VW(ml)	114.6	13
% CO_2	8.0	14
% O_2	12.9	15
% N_2	79.1	16
$4350\sqrt{\ }$	68780.66	17
$As(ft^2)$	50.26	18
(Ts+460)	599.2	19
	Part 2	
mf (mg)	379.5	00
mt (mg)	379.5	01
$VMSTD(f^3)$	36.443	02
Ps ("Hg)	30.67	03
Md	.870	04
(Ts+460)	599.2	05
Qs(scfm)	92,623.4	06

RESULTS
STACK TEST – PARTICULATE

Test # PPE-1		Test # PPE-2		Test # PPE-3	
Value		Value		Value	
Vm (SCF)	42.157	Vm (SCF)	36.645	Vm (SCF)	36.443
Vm (SCM)	1.193	Vm (SCM)	1.037	Vm (SCM)	1.031
Vw gas (CF)	5.920	Vw gas (CF)	6.631	Vw gas (CF)	5.432
% Moisture	12.314	% Moisture	15.322	% Moisture	12.972
Md	.877	Md	.847	Md	.870
MWd	29.976	MWd	29.976	MWd	29.976
MW	28.501	MW	28.141	MW	28.266
Vs (fpm)	2871.793	Vs (fpm)	2341.209	Vs (fpm)	2336.03
ACFM	144,336.4	ACFM	117,669.2	ACFM	117,408.9
Flow (SCFM)	113,868.0	Flow (SCFM)	90,321.1	Flow (SCFM)	92,623.4
Flow (SCMM)	3,222.46	Flow (SCMM)	2,556.1	Flow (SCMM)	2,621.2
% I	90.02	% I	97.48	% I	94.57
% EA	118.2	% EA	118.2	% EA	158.5
Front gr/scf	.2132	Front gr/scf	.1628	Front gr/scf	.1604
Front gm/scm	.4883	Front gm/scm	.3728	Front gm/scm	.3672
Total gr/scf	.2132	Total gr/scf	.1628	Total gr/scf	.1604
Total gm/scm	.4883	Total gm/scm	.3728	Total gm/scm	.3672
Front gr/acf	.1681	Front gr/acf	.1249	Front gr/acf	.1264
Front gm/acm	.3850	Front gm/acm	.2861	Front gm/acm	.2894
Total gr/acf	.1681	Total gr/acf	.1249	Total gr/acf	.1264
Total gm/acm	.3850	Total gm/acm	.2861	Total gm/acm	.2894
Front lb/hr	208.08	Front lb/hr	126.02	Front lb/hr	127.30
Front kg/hr	94.38	Front kg/hr	57.16	Front kg/hr	57.74
Total lb/hr	208.08	Total lb/hr	126.02	Total lb/hr	127.30
Total kg/hr	94.38	Total kg/hr	57.16	Total kg/hr	57.74

BALTIMORE PYROLYSIS
LOAD SHEET
STACK TEST-SO_2/SO_3

Master =			Master =			Master =		
Test = PSI-1			Test = PSI-2			Test = PSI-3		
Enter	Value	Location	Enter	Value	Location	Enter	Value	Location
$V_m(f^3)$	45.35	09	$V_m(f^3)$	36.10	09	$V_m(f^3)$	49.26	09
Pbar("H_g)	29.91	10	Pbar("H_g)	30.25	10	Pbar("H_g)	30.16	10
T_m, °F	88.9	11	T_m, °F	85.0	11	T_m, °F	83.7	11
V_t-$V_b(SO_2)$	2.5	12	V_t-$V_b(SO_2)$	1.9	12	V_t-$V_b(SO_2)$	1.9	12
N	0.01005	13	N	0.01005	13	N	0.01005	13
$V_{soln}(SO_2)$	350	14	$V_{soln}(SO_2)$	342	14	$V_{soln}(SO_2)$	358	14
$V_{aliq}(SO_2)$	0.5	15	$V_{aliq}(SO_2)$	0.5	15	$V_{aliq}(SO_2)$	0.5	15
V_t-$V_b(SO_3)$	4.0	16	V_t-$V_b(SO_3)$	2.8	16	V_t-$V_b(SO_3)$	3.0	16
$V_{soln}(SO_3)$	226	17	$V_{soln}(SO_3)$	273	17	$V_{soln}(SO_3)$	216	17
$V_{aliq}(SO_3)$	10	18	$V_{aliq}(SO_3)$	10	18	$V_{aliq}(SO_3)$	10	18
			RESULTS					
V_m(scf)	43.76		V_m(scf)	35.49		V_m(scf)	48.39	
SO_2 (lb/scf)	2.833×10^{-3}		SO_2 (lb/scf)	2.595×10^{-3}		SO_2 (lb/scf)	1.992×10^{-3}	
SO_2 (ppm)	171.4		SO_2 (ppm)	157.0		SO_2 (ppm)	120.5	
SO_3 (lb/scf)	2.242×10^{-4}		SO_3 (lb/scf)	2.338×10^{-4}		SO_3 (lb/scf)	1.453×10^{-4}	
SO_3 (ppm)	10.85		SO_3 (ppm)	11.32		SO_3 (ppm)	7.034	

BALTIMORE PYROLYSIS
LOAD SHEET
STACK TEST-SO_2/SO_3

Master = _____
Test = PSE-1

Enter	Value	Location
$V_m(f^3)$	37.61	09
Pbar("H_g)	29.91	10
T_m, °F	63.1	11
V_t-$V_b(SO_2)$	1.9	12
N	0.01005	13
$V_{soln}(SO_2)$	376	14
$V_{aliq}(SO_2)$	10	15
V_t-$V_b(SO_3)$	20.0	16
$V_{soln}(SO_3)$	340	17
$V_{aliq}(SO_3)$	100	18

V_m(scf)	38.08
SO_2 (lb/scf)	1.329×10^{-6}
SO_2 (ppm)	8.041
SO_3 (lb/scf)	1.938×10^{-6}
SO_3 (ppm)	9.380

Master = _____
Test = PSE-2

Enter	Value	Location
$V_m(f^3)$	34.92	09
Pbar("H_g)	30.25	10
T_m, °F	58.8	11
V_t-$V_b(SO_2)$	3.4	12
N	0.01005	13
$V_{soln}(SO_2)$	378	14
$V_{aliq}(SO_2)$	10	15
V_t-$V_b(SO_3)$	20	16
$V_{soln}(SO_3)$	291	17
$V_{aliq}(SO_3)$	10	18

RESULTS

V_m(scf)	36.06
SO_2 (lb/scf)	2.525×10^{-6}
SO_2 (ppm)	15.28
SO_3 (lb/scf)	1.752×10^{-6}
SO_3 (ppm)	8.479

Master = _____
Test = PSE-3

Enter	Value	Location
$V_m(f^3)$	35.83	09
Pbar("H_g)	30.16	10
T_m, °F	57.8	11
V_t-$V_b(SO_2)$	1.6	12
N	0.01005	13
$V_{soln}(SO_2)$	401	14
$V_{aliq}(SO_2)$	10	15
V_t-$V_b(SO_3)$	1.6	16
$V_{soln}(SO_3)$	296	17
$V_{aliq}(SO_3)$	10	18

V_m(scf)	36.96
SO_2 (lb/scf)	1.230×10^{-6}
SO_2 (ppm)	7.441
SO_3 (lb/scf)	1.391×10^{-6}
SO_3 (ppm)	6.732

LOAD SHEET
STACK TEST – NOx

Test # PNI-1			Test # PNI-2			Test # PNI-3		
Enter	Value	Location	Enter	Value	Location	Enter	Value	Location
Pf "Hg	28.70		Pf "Hg	29.20		Pf "Hg	29.16	
Tf °F	40		Tf °F	40		Tf °F	38	
Pi "Hg	+4.91		Pi "Hg	+4.91		Pi "Hg	+4.2	
Ti °F	44		Ti °F	44		Ti °F	52	
M (μg)	63.7		M (μg)	4.6		M (μg)	30.4	
Test # PNI-4			Test # PNI-5			Test # PNI-6		
Pf "Hg	26.46		Pf "Hg	27.16		Pf "Hg	30.06	
Tf °F	38		Tf °F	38		Tf °F	38	
Pi "Hg	+0.2		Pi "Hg	+4.2		Pi "Hg	+4.2	
Ti °F	52		Ti °F	60		Ti °F	54	
M (μg)	1.8		M (μg)	1.8		M (μg)	1.8	

RESULTS

Test # PNI-1		Test # PNI-2		Test # PNI-3	
	Value		Value		Value
Vol (scf)	1751.346	Vol (scf)	1801.882	Vol (scf)	1844.964
NOx (lb/scf)	2.255×10^{-6}	NOx (lb/scf)	1.583×10^{-7}	NOx (lb/scf)	1.022×10^{-6}
NOx (gm/m^3)	3.612×10^{-2}	NOx (gm/m^3)	2.535×10^{-3}	NOx (gm/m^3)	1.036×10^{-2}
NOx (ppm)	18.88	NOx (ppm)	1.325	NOx (ppm)	8.551
Test # PNI-4		Test # PNI-5		Test # PNI-6	
Vol (scf)	1946.579	Vol (scf)	1707.369	Vol (scf)	1919.749
NOx (lb/scf)	5.733×10^{-5}	NOx (lb/scf)	6.536×10^{-8}	NOx (lb/scf)	5.813×10^{-5}
NOx (gm/m^3)	9.183×10^{-4}	NOx (gm/m^3)	1.047×10^{-3}	NOx (gm/m^3)	9.312×10^{-4}
NOx (ppm)	0.4799	NOx (ppm)	0.5472	NOx (ppm)	0.4866

LOAD SHEET
STACK TEST – NOx

Test # PNI-7

Enter	Value	Location
Pf "Hg	29.97	
Tf °F	38	
Pi "Hg	4.15	
Ti °F	50	
M (μg)	0.9	

Test # _____

Pf "Hg		
Tf °F		
Pi "Hg		
Ti °F		
M (μg)		

Test # PNI-8

Enter	Value	Location
Pf "Hg	26.67	
Tf °F	38	
Pi "Hg	3.65	
Ti °F	50	
M (μg)	17.5	

Test # _____

Pf "Hg		
Tf °F		
Pi "Hg		
Ti °F		
M (μg)		

Test # PNI-9

Enter	Value	Location
Pf "Hg	28.36	
Tf °F	38	
Pi "Hg	2.65	
Ti °F	50	
M (μg)	9.2	

Test # _____

Pf "Hg		
Tf °F		
Pi "Hg		
Ti °F		
M (μg)		

RESULTS

Test # PNI-7

	Value
Vol (scf)	1682.166
NOx (lb/scf)	3.317×10^{-8}
NOx (gm/m^3)	5.313×10^{-4}
NOx (ppm)	0.02776

Test # _____

Vol (scf)	
NOx (lb/scf)	
NOx (gm/m^3)	
NOx (ppm)	

Test # PNI-8

	Value
Vol (scf)	1695.161
NOx (lb/scf)	6.401×10^{-7}
NOx (gm/m^3)	1.025×10^{-2}
NOx (ppm)	5.358

Test # _____

Vol (scf)	
NOx (lb/scf)	
NOx (gm/m^3)	
NOx (ppm)	

Test # PNI-9

	Value
Vol (scf)	1887.121
NOx (lb/scf)	3.023×10^{-7}
NOx (gm/m^3)	4.842×10^{-3}
NOx (ppm)	2.530

Test # _____

Vol (scf)	
NOx (lb/scf)	
NOx (gm/m^3)	
NOx (ppm)	

LOAD SHEET
STACK TEST – NOx

Test # PNE-1

Enter	Value	Location
Pf "Hg	29.4	
Tf °F	38	
Pi "Hg	+4.91	
Ti °F	44	
M (μg)	37.8	

Test # PNE-2

Enter	Value	Location
Pf "Hg	29.7	
Tf °F	38	
Pi "Hg	+4.91	
Ti °F	44	
M (μg)	13.8	

Test # PNE-3

Enter	Value	Location
Pf "Hg	26.56	
Tf °F	38	
Pi "Hg	+0.2	
Ti °F	52	
M (μg)	29.5	

Test # PNE-4

Pf "Hg	27.86	
Tf °F	38	
Pi "Hg	+4.7	
Ti °F	52	
M (μg)	4.6	

Test # PNE-5

Pf "Hg	29.06	
Tf °F	38	
Pi "Hg	+5.2	
Ti °F	60	
M (μg)	9.2	

Test # PNE-6

Pf "Hg	29.76	
Tf °F	38	
Pi "Hg	+5.2	
Ti °F	54	
M (μg)	29.5	

RESULTS

Test # PNE-1

	Value
Vol (scf)	1811.471
NOx (lb/scf)	1.294×10^{-6}
NOx (gm/m^3)	2.072×10^{-2}
NOx (ppm)	10.83

Test # PNE-2

	Value
Vol (scf)	1835.376
NOx (lb/scf)	4.662×10^{-7}
NOx (gm/m^3)	7.467×10^{-3}
NOx (ppm)	3.902

Test # PNE-3

	Value
Vol (scf)	1945.552
NOx (lb/scf)	9.401×10^{-7}
NOx (gm/m^3)	1.506×10^{-2}
NOx (ppm)	7.870

Test # PNE-4

Vol (scf)	1736.718
NOx (lb/scf)	1.642×10^{-7}
NOx (gm/m^3)	2.630×10^{-3}
NOx (ppm)	1.375

Test # PNE-5

Vol (scf)	1790.604
NOx (lb/scf)	3.186×10^{-7}
NOx (gm/m^3)	5.103×10^{-3}
NOx (ppm)	2.667

Test # PNE-6

Vol (scf)	1826.026
NOx (lb/scf)	1.002×10^{-6}
NOx (gm/m^3)	1.604×10^{-2}
NOx (ppm)	8.384

LOAD SHEET
STACK TEST – NOx

Test = PNE-7			Test = PNE-8			Test = PNE-9		
Enter	Value	Location	Enter	Value	Location	Enter	Value	Location
Pf "Hg	27.56		Pf "Hg	28.36		Pf "Hg	30.16	
Tf °F	38		Tf °F	38		Tf °F	38	
P_i "Hg	+4.65		P_i "Hg	+4.15		P_i "Hg	+2.15	
T_i °F	50		T_i °F	50		T_i °F	50	
M (μg)	8.3		M (μg)	19.4		M (μg)	9.2	
Test = _____			Test = _____			Test = _____		
Pf "Hg			Pf "Hg			Pf "Hg		
Tf °F			Tf °F			Tf °F		
P_i "Hg			P_i "Hg			P_i "Hg		
T_i °F			T_i °F			T_i °F		
M (μg)			M (μg)			M (μg)		

RESULTS

Test = PNE-7		Test = PNE-8		Test = PNE-9	
	Value		Value		Value
Vol (scf)	1684.724	Vol (scf)	1785.057	Vol (scf)	2070.637
NOx (lb/scf)	3.055×10^{-7}	NOx (lb/scf)	6.738×10^{-7}	NOx (lb/scf)	2.755×10^{-7}
NOx (gm/m^3)	4.893×10^{-3}	NOx (gm/m^3)	1.079×10^{-2}	NOx (gm/m^3)	4.412×10^{-3}
NOx (ppm)	2.557	NOx (ppm)	5.641	NOx (ppm)	2.306
Test = _____		Test = _____		Test = _____	
Vol (scf)		Vol (scf)		Vol (scf)	
NOx (lb/scf)		NOx (lb/scf)		NOx (lb/scf)	
NOx (gm/m^3)		NOx (gm/m^3)		NOx (gm/m^3)	
NOx (ppm)		NOx (ppm)		NOx (ppm)	

APPENDIX B
DETAILED DISPERSION MODELING RESULTS

Maximum Ground Level Concentrations from existing configuration Analysis of Concentration as a function of stability and wind speed. 1971 Version D. B. Turner.

Emission Rate (G/sec) = 100.00
Physical Stack Height (M) = 67.10
Stack Gas Temp (Deg k) = 505.00
Ambient Air Temperature (Deg k) = 293.0
Volume Flow (m^3/sec) = 172.30

Stability	Wind Speed (m/sec)	Max. Conc. (G/m^3)	Dist. of Max. (km)	Plume Height (M)
1	.5	99.0000E +00	999.000 (1)	2067.2 (2)
1	.8	58.5767E -06	1.525	1317.2 (2)
1	1.0	63.1151E -06	1.330	1067.2 (2)
1	1.5	71.5077E -06	1.156	733.3 (2)
1	2.0	77.2308E -06	1.023	567.1 (2)
1	2.5	31.3361E -05	0.934	467.1 (2)
1	3.0	34.3072E -05	0.863	400.5 (2)
2	0.5	99.0000E +00	999.000 (1)	2067.2 (2)
2	0.8	18.2399E -06	7.414	1317.2 (2)
2	1.0	21.2899E -06	6.113	1067.2 (2)
2	1.5	27.8516E -06	4.340	733.3 (2)
2	2.0	33.2305E -06	3.423	567.1 (2)
2	2.5	37.7156E -06	2.871	467.5 (2)
2	3.0	41.5061E -06	2.494	400.5 (2)
2	4.0	47.4770E -06	2.015	317.1 (2)
2	5.0	51.8100E -06	1.723	267.1 (2)
3	2.0	22.1766E -06	7.377	567.1 (2)
3	2.5	26.0315E -06	6.372	467.1 (2)
3	3.0	29.1181E -06	5.391	400.5 (2)
3	4.0	35.0835E -06	4.163	317.1 (2)
3	5.0	39.3322E -06	3.443	267.1 (2)
3	7.0	45.3633E -06	2.647	210.0 (2)
3	10.0	50.0072E -06	2.061	167.1
3	12.0	51.3681E -06	1.338	150.4
3	15.0	51.9164E -06	1.615	133.3
4	0.5	99.0000E +00	999.000 (1)	2067.2 (2)
4	0.8	99.0000E +00	999.000 (1)	1317.2 (2)
4	1.0	17.9712E -07	196.025 (3)	1067.2 (2)
4	1.5	32.3392E -07	93.415	733.3 (2)
4	2.0	43.6273E -07	56.066	567.1 (2)
4	2.5	65.4472E -07	33.934	467.1 (2)
4	3.0	93.5756E -07	30.023	400.5 (2)
4	4.0	11.2424E -06	19.742	317.1 (2)
4	5.0	13.9327E -06	14.723	267.1 (2)
4	7.0	18.3926E -06	9.350	210.0 (2)
4	10.0	22.7665E -06	6.736	167.1
4	12.0	24.6242E -06	5.724	150.4
4	15.0	26.3641E -06	4.733	133.3
4	20.0	27.5105E -06	3.315	117.1
5	2.0	36.4435E -05	20.009	199.7
5	2.5	33.5310E -05	18.233	190.2
5	3.0	31.2410E -05	17.105	182.9
5	4.0	27.3017E -05	15.375	172.3
5	5.0	25.2877E -05	14.192	164.9
6	2.0	13.7779E -05	62.333 (1)	177.1
6	2.5	13.2732E -05	56.056	169.2
6	3.0	12.3231E -05	51.190	163.2
6	4.0	12.0533E -05	44.541	154.4
6	5.0	11.4154E -05	40.172	149.2

(1) The distance to the point of maximum concentrations is so great that the same stability is not likely to persist long enough for the plume to travel this far.

(2) The plume is of sufficient height that extreme caution should be used in interpreting this computation as this stability type may not exist to this height. Also wind speed variations with height may exert a dominating influence.

(3) No computation was attempted for this height as the point of maximum concentration is greater than 100 kilometers from the source.

Maximum Ground Level Concentrations from existing configuration Analysis of Concentration as a function of stability and wind speed. 1971 Version, D. B. Turner.

Emission Rate (G/sec) = 100.00
Physical Stack Height (M) = 7.60
Stack Gas Temp (Deg k) = 322.0
Ambient Air Temperature (Deg k) = 293.0
Volume Flow (M^3/sec) = 396.4

Stability	Wind Speed (m/sec)	Max. Conc. (G/m^3)	Dist. of Max. (km)	Plume Height (M)
1	0.5	93.7429E -06	1.524	1317.0 (2)
1	0.8	11.3349E -05	1.222	826.0 (2)
1	1.0	12.4043E -05	1.101	662.3 (2)
1	1.5	14.5644E -05	.912	444.1 (2)
1	2.0	16.2913E -05	.798	334.9 (2)
1	2.5	17.7366E -05	.720	269.5 (2)
1	3.0	18.9894E -05	.662	225.8 (2)
2	0.5	29.1919E -06	7.413	1317.0 (2)
2	0.8	42.1920E -06	4.838	826.0 (2)
2	1.0	50.2587E -06	3.951	662.3 (2)
2	1.5	68.8766E -06	2.741	444.1 (2)
2	2.0	86.0128E -06	2.119	334.9 (2)
2	2.5	10.1980E -05	1.737	269.5 (2)
2	3.0	11.7035E -05	1.478	225.8 (2)
2	4.0	14.4995E -05	1.148	171.3
2	5.0	17.0477E -05	0.946	138.5
3	2.0	62.8513E -06	4.421	334.9 (2)
3	2.5	77.3996E -06	3.481	269.5 (2)
3	3.0	91.5990E -06	2.867	225.8 (2)
3	4.0	11.9038E -05	2.118	171.3
3	5.0	14.5203E -05	1.679	138.5
3	7.0	19.4160E -05	1.190	101.1
3	10.0	25.9982E -05	0.832	73.1
3	12.0	29.9283E -05	0.697	62.2
3	15.0	35.2132E -05	0.564	51.2
4	0.5	99.0000E +00	999.000 (1)	1317.0 (2)
4	0.8	44.3245E -07	118.045 (3)	826.0 (2)
4	1.0	63.9775E -07	76.252	662.3 (2)
4	1.5	12.5019E -06	35.744	444.1 (2)
4	2.0	19.5546E -06	21.782	334.9 (2)
4	2.5	27.2463E -06	14.941	269.5 (2)
4	3.0	35.6382E -06	11.124	225.8 (2)
4	4.0	53.5424E -06	7.062	171.3
4	5.0	72.5102E -06	5.009	138.5
4	7.0	11.3116E -05	3.008	101.1
4	10.0	17.3222E -05	1.811	73.1
4	12.0	21.3177E -05	1.408	62.2
4	15.0	27.1708E -05	1.043	51.2
4	20.0	34.3015E -05	0.795	40.3
5	2.0	18.9477E -05	7.158	112.4
5	2.5	18.4841E -05	6.325	104.9
5	3.0	18.0722E -05	5.723	99.1
5	4.0	17.1890E -05	4.926	90.8
5	5.0	16.5123E -05	4.389	84.8
6	2.0	16.9332E -05	13.310	94.6
6	2.5	16.7940E -05	11.506	88.3
6	3.0	16.6641E -05	10.221	83.6
6	4.0	16.4288E -05	8.492	76.6
6	5.0	16.2198E -05	7.363	71.7

(1) The distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.

(2) The plume is of sufficient height that extreme caution should be used in interpreting this computation as this stability type may not exist to this height. Also wind speed variations with height may exert a dominating influence.

(3) No computation was attempted for this height as the point of maximum concentration is greater than 100 kilometers from the source.

CASE 1 – MOST PROBABLE CONDITIONS – EXISTING CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 7.6
STACK GAS TEMPERATURE (DEG K) = 322.0
VOLUME FLOW (M3/SEC) = 396.4

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 2.1
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 319.4
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .784

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	319.4	0.	55.89	26.92	0.
1.609	319.4	73.66E-16	105.03	43.60	15.47E-17
2.414	319.4	21.70E-11	151.72	56.61	45.57E-13
3.219	319.4	18.12E-09	196.77	67.95	38.05E-11
4.828	319.4	71.16E-08	283.43	86.83	14.94E-09
6.437	319.4	33.72E-07	366.84	103.33	70.80E-09
8.047	319.4	74.71E-07	447.89	118.27	15.69E-08
9.656	319.4	11.70E-06	526.95	132.06	24.57E-08
11.265	319.4	15.01E-06	604.42	144.29	31.52E-08
12.875	319.4	17.43E-06	680.57	155.62	36.60E-08

CASE 2 – MOST PROBABLE CONDITIONS – EXISTING CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 7.6
STACK GAS TEMPERATURE (DEG K) = 322.0
VOLUME FLOW (M3/SEC) = 396.4

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 4.4
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 156.4
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .784

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	156.4	22.50E-11	55.89	26.92	98.98E-13
1.609	156.4	25.36E-07	105.03	43.60	11.16E-08
2.414	156.4	18.55E-06	151.72	56.61	81.60E-08
3.219	156.4	38.28E-06	196.77	67.95	16.84E-07
4.828	156.4	58.06E-06	283.43	86.83	25.55E-07
6.437	156.4	60.71E-06	366.84	103.33	26.71E-07
8.047	156.4	56.97E-06	447.89	118.27	25.07E-07
9.656	156.4	51.56E-06	526.95	132.06	22.69E-07
11.265	156.4	46.10E-06	604.42	144.29	20.28E-07
12.875	156.4	41.22E-06	680.57	155.62	18.14E-07

CASE 3 – MOST PROBABLE CONDITIONS – EXISTING CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 7.6
STACK GAS TEMPERATURE (DEG K) = 322.0
VOLUME FLOW (M3/SEC) = 396.4

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 8.2
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 87.4
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .784

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	87.4	13.19E-06	55.89	26.92	10.82E-07
1.609	87.4	11.34E-05	105.03	43.60	93.01E-07
2.414	87.4	13.71E-05	151.72	56.61	11.24E-06
3.219	87.4	12.69E-05	196.77	67.95	10.40E-06
4.828	87.4	95.00E-06	283.43	86.83	77.90E-07
6.437	87.4	71.59E-06	366.84	103.33	58.70E-07
8.047	87.4	55.76E-06	447.89	118.27	45.72E-07
9.656	87.4	44.80E-06	526.95	132.06	36.74E-07
11.265	87.4	37.04E-06	604.42	144.29	30.38E-07
12.875	87.4	31.30E-06	680.57	155.62	25.67E-07

CASE 4 – UNFAVORABLE CONDITIONS – EXISTING CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 7.6
STACK GAS TEMPERATURE (DEG K) = 322.0
VOLUME FLOW (M3/SEC) = 396.4

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 6
WIND SPEED (M/SEC) = 1.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 116.1
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .095

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	116.1	54.59E-23	27.79	12.03	56.23E-25
1.609	116.1	18.17E-11	52.26	18.85	18.72E-13
2.414	116.1	13.69E-08	75.52	23.96	14.10E-10
3.219	116.1	19.39E-07	97.96	27.87	19.97E-09
4.828	116.1	16.97E-06	141.16	33.66	17.48E-08
6.437	116.1	46.32E-06	182.74	38.47	47.71E-08
8.047	116.1	76.78E-06	223.15	42.38	79.08E-08
9.656	116.1	10.24E-05	262.58	45.71	10.55E-07
11.265	116.1	12.34E-05	301.22	48.73	12.71E-07
12.875	116.1	13.96E-05	339.20	51.51	14.38E-07

CASE 5 – UNFAVORABLE CONDITIONS – EXISTING CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 7.6
STACK GAS TEMPERATURE (DEG K) = 322.0
VOLUME FLOW (M3/SEC) = 396.4

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 6
WIND SPEED (M/SEC) = 3.1

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 82.8
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .284

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	82.8	15.58E-13	27.79	12.03	48.14E-15
1.609	82.8	67.11E-08	52.26	18.85	20.74E-09
2.414	82.8	14.50E-06	75.52	23.96	44.82E-08
3.219	82.8	45.67E-06	97.96	27.87	14.11E-07
4.828	82.8	10.50E-05	141.16	33.66	32.44E-07
6.437	82.2	14.44E-05	182.74	38.47	44.62E-07
8.047	82.8	16.14E-05	223.15	42.38	49.88E-07
9.656	82.8	16.63E-05	262.58	45.71	51.38E-07
11.265	82.8	16.56E-05	301.22	48.73	51.17E-07
12.875	82.8	16L9E/-05	339.20	51.51	50.03E-07

CASE 1 – MOST PROBABLE CONDITIONS – PROPOSED CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 67.1
STACK GAS TEMPERATURE (DEG K) = 505.0
VOLUME FLOW (M3/SEC) = 172.3

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 2.1
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 543.3
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = 1.040

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	468.6	0.	55.89	26.92	0.
1.609	543.3	0.	105.03	43.60	0.
2.414	543.3	17.61E-24	151.72	56.61	36.97E-26
3.219	543.3	14.86E-18	196.77	67.95	31.20E-20
4.828	543.3	19.40E-13	283.43	86.83	40.75E-15
6.437	543.3	39.69E-11	366.84	103.33	83.34E-13
8.047	543.3	74.83E-10	447.89	118.27	15.71E-11
9.656	543.3	45.96E-09	526.95	132.06	96.52E-11
11.265	543.3	14.50E-08	604.42	144.29	30.44E-10
12.875	543.3	32.28E-08	680.57	155.62	67.79E-10

CASE 2 – MOST PROBABLE CONDITIONS – PROPOSED CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 67.1
STACK GAS TEMPERATURE (DEG K) = 505.0
VOLUME FLOW (M3/SEC) = 172.3

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 4.4
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 294.4
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = 1.040

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	258.7	42.00E-24	55.89	26.92	18.48E-25
1.609	294.4	19.81E-14	105.03	43.60	87.17E-16
2.414	294.4	11.31E-10	151.72	56.61	49.78E-12
3.219	294.4	45.46E-09	196.77	67.95	20.00E-10
4.828	294.4	93.84E-08	283.43	86.83	41.29E-09
6.437	294.4	32.98E-07	366.84	103.33	14.51E-08
8.047	294.4	61.66E-07	447.89	118.27	27.13E-08
9.656	294.4	86.65E-07	526.95	132.06	38.12E-08
11.265	294.4	10.35E-06	604.42	144.29	45.54E-08
12.875	294.4	11.41E-06	680.57	155.62	50.22E-08

CASE 3 – MOST PROBABLE CONDITIONS – PROPOSED CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 67.1
STACK GAS TEMPERATURE (DEG K) = 505.0
VOLUME FLOW (M3/SEC) = 172.3

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 4
WIND SPEED (M/SEC) = 8.2
HEIGHT OF MIXING LAYER (M) = 700.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 189.1
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = 1.040

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	169.9	57.43E-13	55.89	26.92	47.10E-14
1.609	189.1	69.90E-09	105.03	43.60	57.31E-10
2.414	189.1	17.11E-07	151.72	56.61	14.03E-08
3.219	189.1	60.53E-07	196.77	67.95	49.63E-08
4.828	189.1	14.74E-06	283.43	86.83	12.09E-07
6.437	189.1	19.21E-06	366.84	103.33	15.75E-07
8.047	189.1	20.42E-06	447.89	118.27	16.75E-07
9.656	189.1	20.02E-06	526.95	132.06	16.42E-07
11.265	189.1	18.87E-06	604.42	144.29	15.47E-07
12.875	189.1	17.52E-06	680.57	155.62	14.37E-07

CASE 4 – UNFAVORABLE CONDITIONS – PROPOSED CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PLYSICAL STACK HEIGHT (M) = 67.1
STACK GAS TEMPERATURE (DEG K) = 505.0
VOLUME FLOW (M3/SEC) = 172.3

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 6
WIND SPEED (M/SEC) = 1.0

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 204.4
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .095

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	204.4	0.	27.79	12.03	0.
1.609	204.4	0.	52.26	18.85	0.
2.414	204.4	27.36E-19	75.52	23.96	28.18E-21
3.219	204.4	24.01E-15	97.96	27.87	24.73E-17
4.828	204.4	63.91E-12	141.16	33.66	65.82E-14
6.437	204.4	32.69E-10	182.74	38.47	33.67E-12
8.047	204.4	29.19E-09	223.15	42.38	30.06E-11
9.656	204.4	11.77E-08	262.58	45.71	12.12E-10
11.265	204.4	31.95E-08	301.22	48.73	32.91E-10
12.875	204.4	67.56E-08	339.20	51.51	69.59E-10

CASE 5 – UNFAVORABLE CONDITIONS – PROPOSED CONFIGURATION

SOURCE STRENGTH (G/SEC) = 100.0
PHYSICAL STACK HEIGHT (M) = 67.1
STACK GAS TEMPERATURE (DEG K) = 505.0
VOLUME FLOW (M3/SEC) = 172.3

AMBIENT AIR TEMPERATURE (DEG K) = 293.0
STABILITY CLASS = 6
WIND SPEED (M/SEC) = 3.1

FINAL EFFECTIVE HEIGHT OF EMISSION (M) = 162.3
DISTANCE TO FINAL EFFECTIVE HEIGHT (KM) = .284

DISTANCE (KM)	HEIGHT (M)	CONCENTRATION (G/CU M)	SIGY (M)	SIGZ (M)	CHI (SEC/M3)
.805	162.3	0.	27.79	12.03	0.
1.609	162.3	83.57E-20	52.26	18.85	25.82E-21
2.414	162.3	62.58E-14	75.52	23.96	19.34E-15
3.219	162.3	16.47E-11	97.96	27.87	50.88E-13
4.828	162.3	19.38E-09	141.16	33.66	59.88E-11
6.437	162.3	20.04E-08	182.74	38.47	61.92E-10
8.047	162.3	71.40E-08	223.15	42.38	22.06E-09
9.656	162.3	15.75E-07	262.58	45.71	48.66E-09
11.265	162.3	27.44E-07	301.22	48.73	84.80E-09
12.875	162.3	41.26E-07	339.20	51.51	12.75E-08

APPENDIX C
AERODYNAMIC DOWNWASH ANALYSIS FOR BALTIMORE CITY PYROLYSIS PLANT

A considerable plume downwash problem has been observed with the existing stack configuration at the pyrolysis plant. As noted in Section V, this phenomenon cannot be treated in a definitive analytic way. However, workers such as Briggs[1][2] and Turner[3] have reported procedures for making first-order approximations of ground level concentrations in situations where downwash occurs. Empirical studies indicate that downwash becomes important when the efflux velocity is less than 1.5 times the wind speed. With the existing configuration, this occurs when the wind speed is more than 3 meters per second (~6.7 miles per hour), a condition which occurs about 50% of the time at the pyrolysis unit. The highest ground level concentrations will result when the wind speed is just high enough to bring the emissions to ground level, because in this case turbulent mixing should be at a minimum. This critical speed is approximately 3 meters per second in the present case.

For a relatively non-elevated, low velocity, low temperature source such as the pyrolysis exhaust, downwash results in a virtual ground level source condition, and the maximum ground level concentrations will occur within the plant boundaries. Consequently, it was considered more appropriate to estimate the maximum levels at the monitoring site nearest the plant, about 700 meters ENE of the boundary. Using the methodology of Briggs, the 1-hour and 24-hour maxima for particulate matter (PM) and sulfur oxides (SO_x) were predicted to be as tabulated below:

	Concentration ($\mu g/m^3$)	
Averaging Period	PM	SO_x
1-Hour	800	98
24-Hour	480	59

[1] Briggs, G. A., Plume Rise, AEC Technical Information Series, 1969.

[2] Briggs, G. A., "Diffusion Estimation for Small Emissions," Air Resources Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration, Oak Ridge, Tennessee, May 1973.

[3] Turner, D. B., Workbook of Atmospheric Dispersion Estimates, 999-AP-26, U.S. Public Health Service, 1969.

The SO_x levels are within the state and national standards, but the 24-hour PM concentration is well above the Maryland serious level (160 $\mu g/m^3$) and the federal primary standard (260 $\mu g/m^3$).

In view of these high short term concentrations, there appeared to be some possibility that an annual standard might be violated. Hence, estimates of expected annual average pollutant concentrations were made by using the Briggs methodology with stability wind rose data. Predictions were made for both the previously mentioned monitoring site and for the point where the maxima occur, about 800 meters from the source. The results are shown below:

	Concentration ($\mu g/m^3$)	
Location	PM	SO_x
Monitoring Site	7.7	1.0
Maximum Concentration Point	8.6	1.1

These concentrations are well below the Maryland and national standards for these pollutants.

The following points should be considered in assessing the preceding results:

- Downwash is a highly site-specific phenomenon and can be handled in only a very approximate way by generalized methodologies.
- Terrain features which increase ground level turbulence and reduce the measured pollutant concentrations are not incorporated in the simple Briggs model.
- In spite of these deficiencies, the consideration of downwash generally improves the predictive accuracy of diffusion calculations for sources exhibiting essentially neutral buoyancy such as the existing pyrolysis configuration.

In summary, plume downwash appears to greatly increase ground level concentrations with the existing configuration. The proposed tall stack-electrostatic precipitator combination with its higher exhaust velocity and much higher gas temperature should completely alleviate the downwash problem.